Vol 2 Compl

PAVING AND MUNICIPAL ENGINEERING.

A Journal Devoted Specially to the Making of Roads and Streets; to the Construction of Water-Works, Bridges, Sewers, and Street Lighting Plants, and to all Matters Pertaining to Public Improvement in Cities.

VOL. II. INDIANAPOLIS, IND., JUNE, 1891. No. 1.

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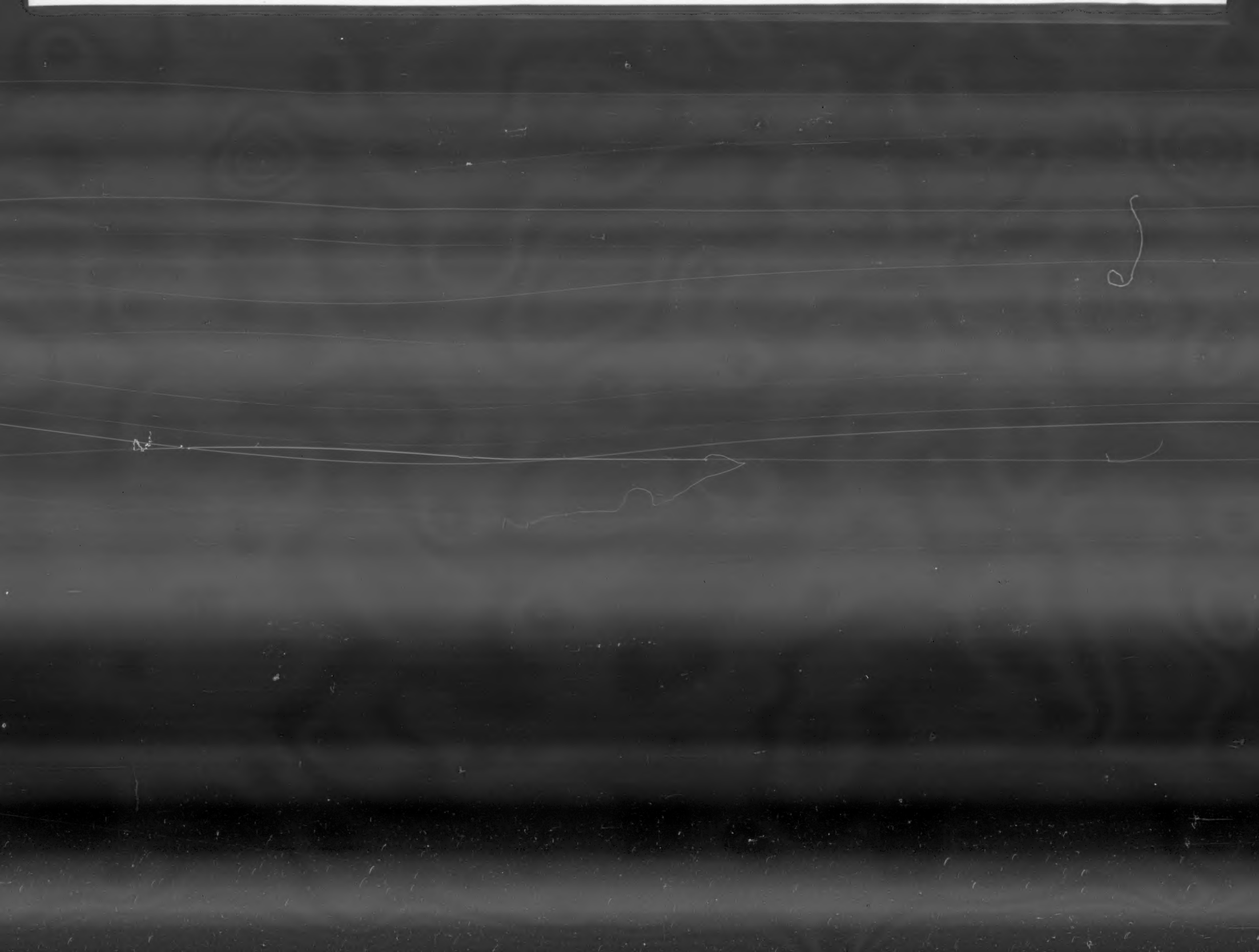

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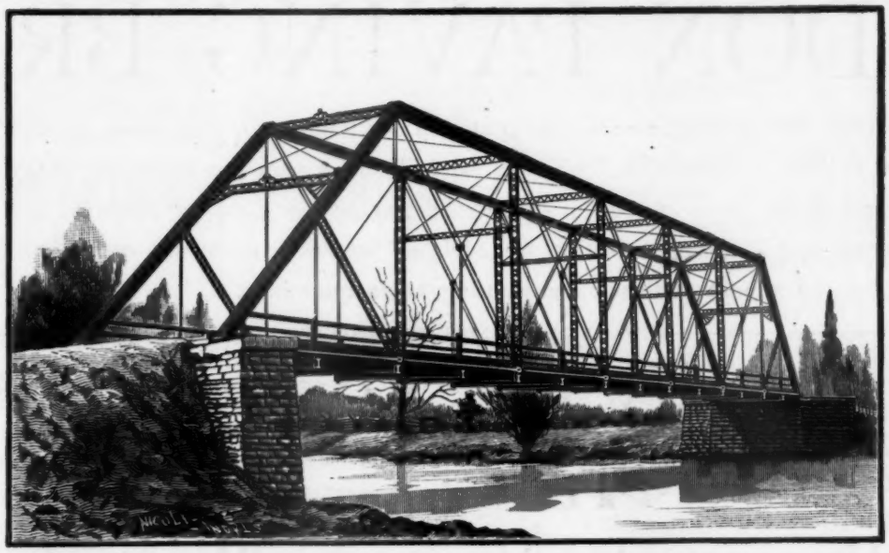

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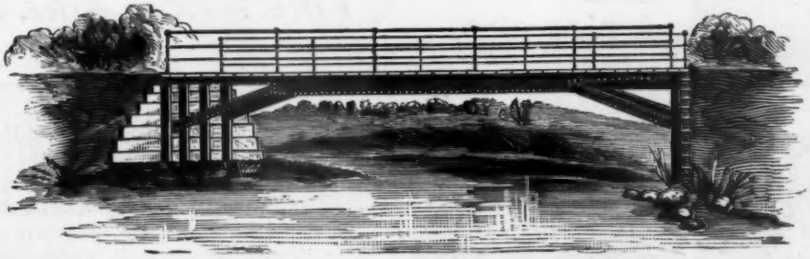

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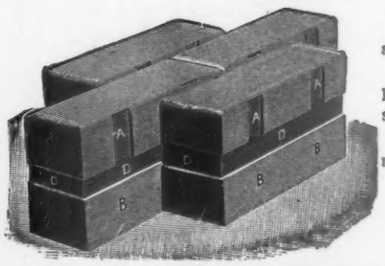

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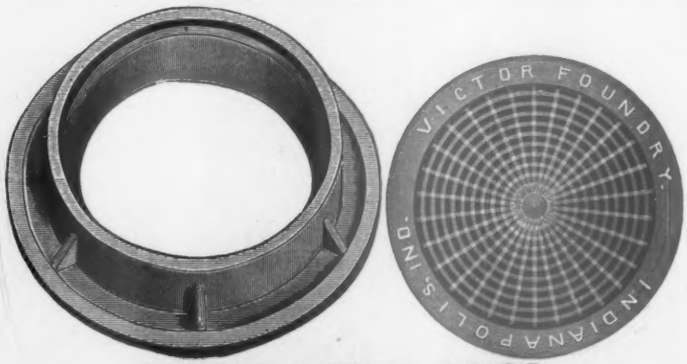

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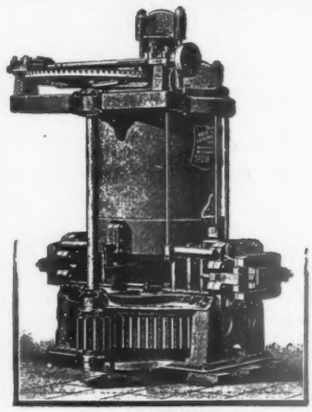

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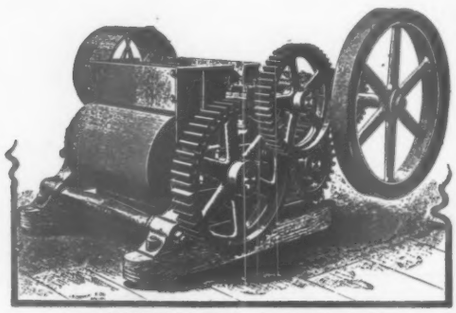

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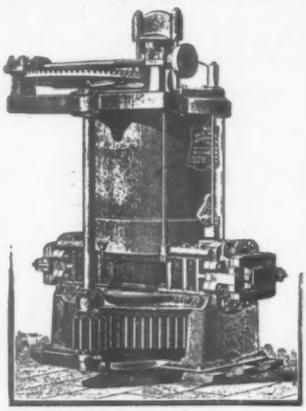

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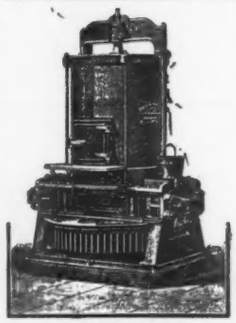

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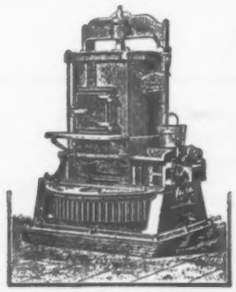

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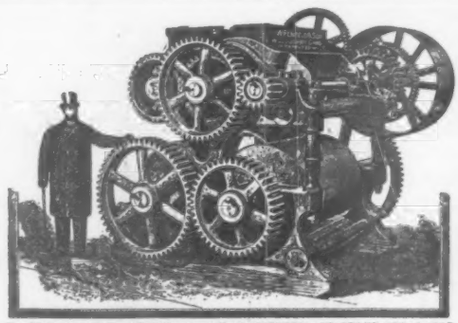

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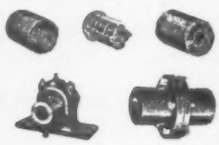

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Communications are invited, and all requests for special information on the subjects treated by this journal will receive careful attention.

Articles relating to the different branches of municipal engineering are desired. Stamps should accompany manuscripts for return postage if unavailable.

Vol. II. INDIANAPOLIS, IND., JUNE, 1891. No. 1.

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The columns of this publication are open to the discussion of all subjects relating to paving, sewerage, water-works, street-lighting, and the physical improvement of cities. Practical information as to the merits of materials used in such work and new methods, with photographs and drawings, which may be used for illustration, are especially desired. We are glad to get brief notes as to proposed improvements and the letting of large contracts.

City engineers are requested to send us as early as possible copies of their annual reports, which will be given proper notice.

Articles relating to methods of road making and maintenance are invited.

PAVING BRICK AND BRICK PAVEMENTS.

By C. P. Chase.

The history of the manufacture of brick during the last ten years is that of wonderful change and advancement. This is due mostly to the use of brick for paving, thereby increasing the demand and necessitating the use of improved machinery and methods of handling.

A convincing evidence of this advance is shown in the tests of strength of these brick; taking the tests as given in standard engineering books, eight or ten years ago, we find in Trautwine the strength of brick given as 500 to 4,200 pounds per square inch. Now, taking recent tests, in experiments made at Watertown Arsenal, the strength ran from 5,000 to 22,000 pounds per square inch. In the tests of Illinois paving brick, by Prof. I. O. Baker, we find an average strength in hard paving brick of over 5,000 pounds per square inch. The average crushing strength of ten varieties of paving brick, much used in the west, I found to be 7,150 pounds to the square inch. There are a number of causes which have brought about this improvement, as manner of burning, better classes of clay, and a more thorough and uniform mixing of the material resulting from the use of mixing machines.

It was only twenty years ago that brick were first used to any extent for street pavements; what were known as paving brick had been on the market for some time, but their use was limited to tunnels and foundations. The brick of to-day, however, must not be judged by those of twenty, or even ten, years ago, as the quality of brick has so much improved that what would bring a fair price ten years ago is hardly marketable now.

Most of the paving brick now in use are made from the inferior grades of fire clay, a hydrated silicate of alumina, generally containing traces of magnesia, iron, lime and potash, which make the brick more flexible and easier to fuse. Three to four per cent. of siliceous matter renders it fusible. Lime is very injurious to the paving brick, as it is changed to caustic lime in burning, and a small amount of moisture reaching this will cause it to slack and disintegrate the brick. A small amount of magnesia aids in producing vitrifaction. Iron is not injurious in a paving brick; but in a brick to resist high temperature six per cent. of iron makes it useless. Alumina, and not iron, gives elasticity to the brick, is tough and binding, readily fusing in the presence of silica. The other constituents are impurities and act as a flux.

The plasticity and flexibility of the clay is due greatly to the fineness of the particles and has a direct bearing on the strength of the brick. Uniform fineness is positively necessary to obtain the best results. The clay must be in a fine powder before mixing; it is then carefully tempered and is ready to be shaped into brick. If the clay is neither dry nor fine it should be calcined and then finely ground. Of two samples of clay, one fine and one coarse, the fine clay will vitrify quicker, the stronger and harder the brick will be, and it will stand abrasion much better. In examining and breaking brick, it will be found that if the clay was not properly prepared and the brick thereby contains small pebbles or other coarse material, it will crack or spall around these and but a slight blow will be necessary to break it. In a large number of briquettes which were tested for tensile strength it was found that when coarse material was present the break occurred *around* this material and the strength of the briquette fell below the average. The color of different varieties of brick has nothing to do with their strength; but in some varieties, vitrifaction is shown by the change of color in burning, though bituminous matter will also effect changes in color. One of the chief causes of lack of uniformity is the manner of burning. Many companies having good clay and first-class mixing machines have failed to make a good brick because they could not be induced to give up the old fashioned updraft kilns. It is an *impossibility* to come anywhere near uniformity using one of these. Three classes of brick will be produced: soft outside brick, a fair brick in the middle courses, and brittle, over-burnt ones near the arches, or the outside brick being good, the courses near the fires are fused into one mass. With the oven or down-draft kiln, seventy-five to ninety per cent. of good paving brick can be produced and the remaining twenty-five to ten per cent. make excellent brick for foundations. Another improve-

147429

ment, which has given more uniform results where used, is the substitution of oil and natural gas for wood and coal. These fuels have been used with considerable success by a number of brick companies: At Cleveland, Ohio, a kiln of twenty-five thousand brick are burned in four days, using twenty-five burners; a saving of three days in time, and one man does the work of three. The Purington-Kimball Brick Co., of Chicago, use crude or waste oil after the naphtha has been extracted.

In the burning, hot oil, hot air and steam are necessary. The burners are placed in the arches and the brick are burnt in sixty hours. The saving of wood is thirty-five per cent., total saving over old methods, thirty-three and one-third per cent. These are not paving brick, but the illustration will serve as an example of the economy of the new method. The company have no clay which would make a good paving brick; but in several places, paving brick, burned by natural gas, have been a success. This would probably be a profitable line to experiment in.

The result of the burning, if properly conducted, is a semifused brick, really an inferior glass, due to the combination of silica, alumina and some base. The chemistry of burning is as follows: At 100 degrees C. the water held in mechanical suspension is driven off. That held in chemical combination is driven off at a little below red heat. At a red heat, the carbonates are decomposed and organic matter is consumed. At a white heat, vitrifaction takes place, and from here the kiln is gradually cooled.

The average composition of clays used for paving brick, I find to be 69.1 per cent. silica, 15.5 per cent. alumina, 5 per cent. of chemically combined water, 2 per cent. moisture, 2.5 per cent. iron, 2.5 per cent. magnesia, 3 per cent. lime. This is from the analysis of ten of our best brick, which I give in detail below with accompanying tests of compressive strength.

HALE PAVING BRICK.

Silica	66.30	Magnesia	0.42
Alumina	19.53	Moisture at 212 deg	2.08
Iron Sesquioxide	4.07	Combined water	5.16
Lime	1.87	Undetermined	0.57
			100.00

MINGO FIRE-CLAY, HAYDENSVILLE, O.

Silica	72.24	Magnesia	trace
Alumina	16.87	Alkali	1.09
Iron	0.16	Water	5.14
Lime	0.50		
			100.00

This clay in its natural state is quite compact and has the appearance of a fine grained sandstone. The blocks made from it are five and three-fourths by five and three-fourths inches by four and three-fourths inches deep, weigh nine and one-half pounds, and are salt glazed; in burning they are subjected to a heat of 2,000 degrees F. for ten days.

BURLINGTON BRICK, "GRANITE BRICK COMPANY."

Silica	77.40	Magnesia	1.91
Ferric oxide	3.29	Potash	3.76
Alumina	11.74	Soda	.47
Lime	1.60	Mn (trace with FeO)	
			100.17

The Bloomington brick are of three kinds, classed according to the clay from which they are made.

A. Yellow, aluminous clay, very fine and plastic, found three feet below the surface; in burning, it turns to a grayish red.

B. Hard pan clay, just beneath A, and lies in a stratum one and a half feet thick, and is hard to crush; in burning, it turns from pink to a cream color.

C. Is a blue clay directly beneath the hard pan, and has a depth of from one to six feet, and burns to a chalk white.

An analysis of the best Bloomington paving brick gave the following result:

Silica	67.80	Water	0.20
Alumina	11.55	Manganese	trace
Ferric oxide	4.31	Chlorides	trace
Lime	8.90	Alkali and loss	2.42
Magnesia	5.32	Titanic acid	trace
			100.00

The next brick we will take up is called a "Slate Brick," and is manufactured by the American Brick and Tile Co., of Phillipsburg, New Jersey.

ANALYSIS.

Silica	56.78	Sulphur	0.89
Alumina	17.38	Phosphoric	0.133
Lime	4.14	Water and carbonic acid	7.600
Magnesia	3.15	Alkali and organic matter	3.427
Iron peroxide	6.50		
			99.910

The clay is crushed and then ground in a pan, one machine having six brick in a mold, and makes thirty-five thousand in ten hours. The crushing strength averages between seven thousand and seven thousand five hundred pounds per square inch.

The clay recently discovered near Clinton, Iowa, occurs in the Hudson shales, in an immense bed along the Mississippi river. It is of two classes; the upper part of the bed being a dark green, when moist, and the lower part much lighter color. Its melting point is very low for clay, making it easy to vitrify, and quickly burned.

ANALYSIS OF CLAY.

Silica	75.5	Potash	4.5
Iron	4.0	Manganese	trace
Alumina	13.4	Water com	3.
Lime	0.5		
			100.9

An analysis from another part of the bed gave less iron and considerable more alumina and a small amount more of lime and combined water.

In England, brick made from the Stourbridge fire-clay have quite a good reputation; an analysis of this clay is given below for comparison with our own.

STOURBRIDGE FIRE-CLAY, ENGLAND.

Silica	73.82	Magnesia	trace
Alumina	15.88	Alkali	0.90
Iron	2.92	Water	6.45
Lime	trace		
			100.00

It will be seen that its composition is almost identical to that of our own clays.

The manner in which tests for compressive strength are made should always be given; that is, whether the brick were on end, on edge or flatwise, as it has been found that the results in strength vary as 2, 3 and 4 for the above positions.

TESTS OF FOUR HALE PAVING BRICK.

Width in inches.	Compressive Surface.		Sect. area in square inches.	First Crack in pounds.	Crushing Total.	Strength Pounds per sq. in.
3.60	7.42	2.13	15.8	36500	111200	7038
3.55	7.53	2.17	* 16.34	45500	89200	5459
*3.55	7.48	2.14	16.01	27000	66300	4141
*3.45	7.43	2.11	15.68	36500	64600	4120

*Failure occurred in detail, bricks flaking off from one side. These brick are furnished to the trade, 8 inches long, 4 inches in depth and 2½ inches wide. Tested on edge.

TESTS BURLINGTON BRICK.

Name.	Size in in.	Area of cross Sect.	First Crack in Pounds.	Crushing Total.	Strength. lbs. per sq. in.
A. Burlington	8 x 3 x 2	8.6094	35600	58000	6736.8
B. Burlington	7 x 3 x 2	9.2031	40000	84800	9214.3

These bricks were tested on end; on breaking them they presented a uniform and compact structure well vitrified. The clay is a hard blue clay resembling sandstone.

COMPRESSIVE STRENGTH.

Name.		Crushing strength in lbs. per sq. in.	
Bloomington	"A"	12920	Maximum
"	"	11520	Mean
"	"	10120	Minimum
"	"B"	9893	
"	"C"	9386	

This test was not made on full size brick, but on specimens three-fourths of an inch by three-fourths of an inch by one and one-half inches taken from the brick.

In the manufacture, the clay is tempered in a pugmill, molded into brick by hand, dried in a yard and burned ninety-six to one hundred and twenty hours in up-draft kilns with wood and coal as fuel. The brick are seven inches by three and one-half inches by two and one-fourth inches in size, and sell at $8.50 per thousand at the yards. The Virden brick is manufactured at Virden, Ill., the material being a slaty clay found in a layer twenty-five feet thick, and 275 feet under ground. Its composition is similar to most of the Illinois fire-clays. The bricks are eight and one-half inches by four and one-fourth inches, compact and uniform; when struck, they give out a sharp metallic ring.

The clay is crushed in a dry pan crusher; then placed in a tempering machine from which it is forced by a screw in eight and one-half inches by four and one-half inches section, run over by rollers and is cut off by hand.

It is then placed in drying sheds and when all moisture is driven off the brick are burned in down-draft kilns seventy to ninety hours.

COMPRESSIVE STRENGTH.

Name	Crushing strength in lbs. per sq. in.	
Virden A	10000	maximum
" "	9630	mean
" "	9361	minimum
" B	9173	
" C	8862	

The Myenburg Brick Company have a brick (patent) into which a material is put to assist in vitrification. The brick is hard, smooth and quite durable.

Ottawa Brick. The Ottawa Fire Clay and Brick Company use one-half fire-clay and one-half ordinary red brick clay. The clay is well ground, tempered, thoroughly dried and then burned in down-draft kilns. When broken, they presented an exceedingly compact and uniform structure. The interior was of a gray metallic color, thoroughly vitrified and very hard. They are more of a block than a brick, being 12×3¾×5 inches. In street use they have given general satisfaction and do not wear slippery nor shiny. At Toronto, Canada, a slag brick has been experimented with. It is gray in color, six inches long, four inches wide, six inches deep, heavy, very hard and slippery and costs about sixty cents more per yard than cedar block. This brick comes from England.

The brick made at Empire, Ohio, are of a cream color, quite uniform in structure and measure 8×2⅝×4 inches. The clay is a light blue fire-clay and is burned in up-draft kilns, with natural gas as fuel.

At Bardolph, Ill., a first-class paving brick is manufactured. They are very tough and hard, but would be improved by finer grinding of the clay. This brick has rounded edges, instead of the sharp angular edge, which the author thinks is an advantage, as it chips less easily.

At New Brighton, Pa., a good quality of brick are manufactured, which come up to the standard of a fair paving brick.

Wheeling, W. Va., has a brick which is a combination of iron-slag and fire-clay; it makes a fair paving brick.

The London Mills brick is manufactured in Illinois, and has given satisfaction where used.

The Galesburg brick are well known as a paving brick. They are a hard burned brick, having a crushing strength of from 5,000 to 7,000 pounds per square inch and take up but a small per cent. of water.

Now that we have discussed the merits and strength of different paving brick, we will compare them with different paving stone, mainly granite.

Name.	Crushing strength in pounds per sq. in. Maximum	Minimum
Hard Brick	22000	4000
Limestone	20000	7000
Granite	21000	12000
Marble	20000	8000
Sandstone	15000	5000
Trap Rock, N. J.	24000	20000

And the following results of tests of our different granites will show that there is almost as much difference in the strength of granite as brick:

TESTS MADE ON TWO-INCH CUBES.

Crushing Strength, Granites, United States.

Name.		Size of specimens.	First crack in pounds.	Crushing total lbs.	Strength lbs per. sq in.
Richmond, Va.	1.	2x2x2 in.	30200	30200	7550
" "	2.	"	22000	30100	7522
" "	3.	"	28600	45280	11320
" "	4.	"	23510	25640	6410
Marlborough, N. H.	1.	"	13850	21900	5475
" "	2.	"	18290	19530	4882
" "	3.	"	20130	20130	5045
North Jay, Me.	1.	"	16880	20000	5000
" "	2.	"	17130	19140	4785
Georgia.	1.	"	18590	20200	5050
"	2.	"	14870	18320	4580
"	3.	"	17370	19500	4875
"	4.	"	16320	17500	4375
"	5.	"	15700	20980	5245
Haynes Stone, Ga.	1.	"	.....	54450	13610
" " "	2.	"	.....	49000	12250
Beauchamp Stone Mn., "	1.	"	.....	49250	12312
" " "	2.	"	.....	66000	16500
Lithonia "	1.	"	.....	74650	18662
" "	2.	"	.....	71900	17975
Richmond, Va.	1.	"	.....	68000	17000
" "	2.	"	.....	70260	17565

The first of these were made at Cincinnati, in August, 1886, the last eight were made at the Bureau of Ordnance of Navy Department, Washington, D. C., in 1886-7.

In a series of comparative tests of hard burned bricks, made at Buda-Pesth, Hungary, the following results were obtained:

Name.	Area sec. in Centimeters.	Crushing Strength. Minimum Lbs. per sq. cm.	Maximum Lbs. per sq. cm.
Brick, 5 samples	1 cm. x 1 cm.	4182	4763
" 3 "	" " "	5214	6167
" " "	" " "	5651 unbroken	6996
Granite, 22 samples from three quarries.....	" " "	1911	3672

NOTE.—1 sq. cm. is .155 of a square inch.

It can be seen in the table that the minimum crushing strength of the brick was in no case so low as the maximum of the granite. If the strength of the specimens would increase proportionally with the size up to one square inch, we would have, maximum strength of brick 45,164, minimum 26,973 pounds per square inch. Maximum strength of granite 23,684, minimum 12,323 pounds per square inch.

The tests made at Berlin, Germany, on ceramite brick upon twenty three cubes similar to the above, the maximum crushing strength per square cm. was 8,170 pounds, mean 6,275 pounds, minimum 4,832 pounds. This would give a maximum crushing strength of 52,696 pounds per square inch. These brick average above any natural stone in compressive strength. Of course, they were exceptional cases, but they show the possibilities of brick. On examining the preceding tables of analysis, it is seen that the clays that make good paving brick have nearly the same ingredients and in the same proportion. Such clays are nearly always to be found in any region where coal exists. If, then, you find a clay of this composition, a good brick can be made from it if properly worked up. The result of the burning is a hard, tough and slightly elastic brick; really an inferior glass. It will not break in handling, and can be unloaded, by dumping from a cart, without injury. A vitrified brick is impervious to water and other fluids; and no brick should enter a pavement, which, when immersed, will absorb more than one-tenth of its weight of water in ten days. The test for absorption is one of the best and its importance will be illustrated further on.

The following tests for absorption were made on brick thoroughly dried, then immersed, and results taken for three, five and ten days.

The specific gravity, which should be two, or more, in a paving brick, is also given. The amount of water taken up varied almost directly with the vitrification of the brick; in nearly all of the specimens the burning could have been carried a little farther to advantage:

Comparative per cent of Absorption.

Name.	Spec. Grav.	Brick immersed for 3 Days.	5 Days.	10 Days.
Ottawa, Ill., 1	2.3507	3.22	3.80	4.12
" 2	2.3604	3.00	3.08	3.90
Burlington, Ia., 1	2.2982	0.90	1.10	1.17
" 2	2.2786	2.34	2.48	2.51
London Mills	2.2314	3.42	3.78	3.80
Clinton, Ia., 1	2.2523	3.12	3.41	3.46
" 2	2.2834	2.01	2.12	2.20
Galesburg, Ill., 1	2.2432	5.32	5.54	5.545
" 2	2.2400	3.61	3.63	3.700
Bardolph, Ill., 1	2.0300	3.37	3.44	3.68
" 2	2.1088	2.00	2.65	2.69
Empire, O.	2.1700	5.00	5.85	5.864
Le Clair, Ia	2.1743	2.86	3.12	3.20
Bloomington, A	2.1852	3.79	3.92	4.06
" B	2.3045	3.18	3.19	3.37
" C	2.2269	1.87	2.20	2.70
Varden, Ill., A	2.3166	3.10	3.12	3.82
" B	2.4150	7.67	7.96	8.71
" C	2.3601	7.11	7.48	8.70
Hayden Block, 1	2.2861	3.25	3.38	3.64
" 2	2.2760	1.98	2.16	2.83
Common Red	1.8210	15.13	16.06	16.50

All these brick, except the common red brick, came up to the standards of having a specific gravity of more than 2 and absorbing less than one-tenth of their weight of water in ten days' soaking.

In a few localities brick have been used for paving where they were dipped in hot tar, or creosote, to make them impervious to water and frost, but this is only a temporary protection, and would only improve a soft porous brick, which, of course, is of no use in a pavement. A vitrified brick would take up practically no tar or creosote.

Whether the brick are soft or hard depends mostly on the skill of the burner; different clays vary considerable in the time it takes to burn them. This can only be found by trial burning, under the direction of a man experienced in burning with oven kilns. Oil or gas will give much more uniform results than coal or wood, and in some localities are much cheaper.

The amount of shrinkage, which is considerable in most clays, can only be found by trial, and from this the size of mold is regulated. [TO BE CONTINUED]

STREET CLEANING IN PARIS.

By Louis H. Gibson.

THE streets of our cities can not be cleaned without the use of large quantities of water. Given the smooth, perfect roadway and an adequate sewer system, we then require a large water supply. The streets must be sprinkled and swept, and the gutters slushed. They must be filled with running water.

An asphalt street which is impervious to moisture, if not kept perfectly clean, is more unhealthful than a dirt or other road that is pervious. In the latter case the impurities are deodorized and dissipated by natural means. The soil takes them up and by processes of aeration and otherwise they are rendered harmless. In the case of an impervious pavement, like asphalt, the impurities are on the surface, and if not removed, lie there in a festering mass to tincture and poison with their exhalations the general surroundings. This is measureably true of all pavements which in the character of their composition are more or less impervious. Thus it is that when we build good pavements there is made necessary the work of caring for them. The perfect pavement creates new conditions, invites extra precautions, in order to contribute to the health and well being of those who live in cities. If not properly cared for, the hygienic qualities of a first-class pavement are not so good as those of a dirt road. A dirt road is its own purifier, its own deodorizer. An asphalt or other artificial covering prevents natural purification and deodorization. Thus with artificial covering of streets we must have artificial purification. This is not guess work. It is experience; it is history, very simple, but not generally appreciated.

In Paris the streets are cleaned every day. They are sprinkled and swept and the gutters slushed. This work really begins early in the morning. The carts go through the streets, take the garbage and ashes from the galvanized iron buckets and barrel-like receptacles which are on the sidewalk at this hour. Any particles that are spilled on the sidewalk or street are swept into a shovel, thrown into the cart, and all hauled to the cleansing works. Depending on the state of the weather, the street may then be sprinkled. After this the impurities are swept into the gutters by horse-power sweepers, three diagonally abreast. Then it is that the water is turned on in large volumes, and men or women with willow brooms scour the gutters, pushing and sweeping the water and its contained impurities in the direction of the sewer opening. This scours the gutter and the pavement some three or four feet out from the curbing. In a short time, however, the water begins to run clear; one can see the clear, yellow sand lying in the bottom of it, as though it had not known uncleanliness. It is not an uncommon thing to see the women who sell flowers from their carts on the street dipping their bouquets into this water, for the purpose of adding to their freshness. Every street, passage, court, alley, public square is cleaned and purified every day in this way. In some of the narrow and less frequented streets and passages the work is naturally delayed until later in the day. In this way the water supply is not overtaxed.

I understand that Paris has carried the use of water in slushing and cleaning streets and sewers further than any other city of Europe. I remember reading many years ago about their arrangements for flushing sewers. I now learn that they have two systems of water supply, one distinctly for flushing and another for drinking and general household and culinary purposes. The water which is used in the streets is pumped directly from the Seine. That for drinking purposes comes from a more remote source.

While we may well study Paris in the care of its streets, we can not derive anything from the sanitary arrangement of its buildings. In the courts, or under all structures there are large cemented vaults or cistern-like structures which receive the deposits from the water-closets and other offal of this character. When these vaults are full they are pumped out by the night carts. The soil pipes and other house drains are usually connected with the water-closets and sinks without traps, the only trap being just before the drain enters the cistern or vault mentioned. However, the water-closet rooms open to the outside, and are very generally ventilated by internal flues. All of this is bad enough, and goes to show that a people who are generally very bright and wise may be badly at fault in regard to certain things. They may be in a state of high development with respect to one branch of sanitary engineering, and in a condition almost approaching barbarism as regards another. Their internal plumbing is certainly barbarous, and the care of their streets and the sewer arrangements connected therewith are of a high order.

In a great city the sweeping of the street impurities into the gutters is not to be thought of unless they are cared for regularly and in connection with the abundant use of water. Furthermore, this plan assumes that the sewers are in good condition, and provided for all streets.

It is not to be expected that all American cities can adopt a plan of this kind and carry it out as it is done here. Certainly not at once. The expense of preparation is great, and again most of our cities get their supply of water from private corporations. However, it is well to bear in mind that a city can not be well cared for, can not be healthful or pleasant to live in, without smooth, impervious streets, a complete sewer system and an abundant public water supply. There is no more reason why a water company should be controlled by a private organization than that

the streets and sewers should be controlled in the same way. The ownership of the water-works plant is one thing which all cities should have in mind. Where it is not possible at present the thought of ownership should be constant, so that the first opportunity may bring about the desired result.

EXPERIENCE IN STREET PAVING.

By Stevenson Toule.

[Concluded from May number.]

CAREFUL observation has been made during a long period to determine the relative slipperiness of the different pavements.

In London it is found that a horse will travel before falling: on granite, 132 miles; on asphalt, 191 miles; on wood, 330 miles.

The experience of Paris I was not able to ascertain by figures, but the French engineers give a decided preference to asphalt, claiming that when clean it is the least slippery and falls are less frequent, as horses grow more used to this pavement; drivers, too, are more careful.

The practice everywhere is to sand the asphalt and wood in certain conditions of weather, but very sparingly.

As to the comparative merits of pavements, European authorities agree that for economy, cleanliness, comfort and sanitary reasons the asphalt surpasses all others, wood comes next; while noiseless, it is expensive to maintain and more difficult to clean. It has, of course, since then been extensively repaired, but nevertheless the carriage way has never once been stopped for a general repair of the surface for seventeen years. It is this year entirely to be repaved with asphalt.

After Cheapside, many other streets in the city were paved with compressed asphalt, but the objection raised to it on account of the alleged slipperiness were very great. Nevertheless, noiseless pavements began to be largely demanded in the principal streets of the city, and wood pavements, which were not so much open to the objection of slipperiness, again began to be laid. For some years it was a struggle between wood and asphalt, as to which should become the permanent substitute for granite pavements, with which material nearly the whole of the public highways of the city were laid up to the year 1871, when the commissions gradually began to extend the asphalt pavements.

Experimental pieces of asphalt were laid afterwards in other parts of the metropolis, and the pavement became the subject of many reports by myself, one of which dealt generally with the question of the relative advantages of asphalt and granite, and was reported to the commission on the 24th of July, 1871.

Great complaints being still made of the slipperiness of asphalt, and doubts having arisen as to whether the complaints were fully justified, the commissioners, in 1873, referred it to me to have observations taken of the accidents upon asphalt, wood and granite pavements, respectively. It was a matter which occupied me for many months, and resulted in my report upon the accidents to horses on carriage-way pavements, which was presented to the commission on 16th December, 1873.

Since that the granite in nearly the whole of the main thoroughfares of the city has been replaced by either asphalt or wood, but mainly by asphalt, which has also replaced the granite. Stone is always preferred when a substantial pavement is needed for extra heavy traffic and when comfort is not sought. Very few stone pavements are now laid even in the business thoroughfares of London and Paris.

The use of asphalt is daily extending, especially in Berlin. The fact that the German engineers have adopted it, who are critical and able, is proof of its superiority. I would also refer to Colonel Haywood's report (1888), on the advisability of continuing its use in London after the expiration of the seventeen years guarantee which are about to expire (1888), in which he says:

"In 1869, an experimental piece of compressed asphalt pavement having an area of about four hundred yards, was laid by and at the expense of the Val-de Travers Company in the carriage way of Threadneedle street, near to Finch lane. That pavement, which of course has had many repairs done to it since it was first laid, still remains, and is in good condition. Soon afterwards the cleanliness, the absence of noise, and the comfort felt by the community generally, from the asphalt pavement enlisted the favorable opinion of the public; but certainly also has the strong dislike of the drivers of the vehicles on account of its slipperiness. The qualities of the pavement were then carefully watched by myself, for very largely the responsibility of its having been made rested on me.

"Having made a careful study of the asphalt pavements at Paris and elsewhere, and thinking that the value of the material could not be too soon tested, and tested in the fullest possible manner, I advised that Cheapside and the Poultry should be paved with the Val-de-Travers compressed asphalt, which was accordingly done at the latter end of the year 1870. In 1879, the Poultry having been widened, it involved relaying the carriage way anew with asphalt, but on the entire length of Cheapside the existing pavement is that which was laid in 1870, or seventeen years ago, in a large number of the minor streets.

"In selecting the kind of pavement suited to the different streets I have been governed by the extensive practice in European cities and in this country. In Washington the United States Government has given the subject of asphalt pavement careful study. Extensive experiments have been made of the different kinds of asphalt pavement, and accurate records of their relative durability kept. The pavement that has given the best satisfaction is made of a mixture of Trinidad asphalt, sand and limestone, laid on a hydraulic concrete base, known as the standard asphalt pavement."

After a thorough examination of the asphalt pavements in Washington and Buffalo and other cities, and its favorable comparison with the foreign pavement that has been laid in this country, I recommended its use in this city in competition with the foreign natural rock asphalt pavements. It is in my judgment less slippery than the rock asphalt. The experience with the patent coal-tar pavements has not been satisfactory and have not warranted their use. For residential streets and streets in the vicinity of hospitals and public buildings and pleasure drives, asphalt was selected on account of its economy and the comfort of a noiseless pavement.

For business thoroughfares and streets subject to heavy traffic granite was selected, laid on a concrete foundation and having the joints filled with coal-tar and gravel.

The best practice is to lay asphalt pavements on a hydraulic concrete foundation, but in many streets proposed to be paved with asphalt, the old pavement, although much worn and sunken, was found to be solid and firm, and with proper preparation would make a suitable foundation for the pavement; and as contractors were willing to guarantee the pavement for the same long period as on concrete, it was decided to omit the expensive concrete and use the old-pavement for the foundation, a saving of one-quarter of the cost.

Accordingly where the old pavement was firm, most of the cross-town residential streets have been paved in this manner, and have worn equally as satisfactory as streets with the concrete foundation.

Asphalt pavement requires the greatest skill and care in preparation, not only in laying, but in the selection of the best materials.

Contractors, when they are required to give a long guarantee, for maintenance, find it to their advantage to use only suitable materials and skilled labor, and do the best possible work.

On account of our contract laws, the manner of securing this guarantee differs from the practice in Europe, which is to require of the contractor guarantee for seventeen years, the contractor being paid a fixed price per yard per year (except the first two years, which are without charge), measured over the whole surface of the street.

The asphalt pavements may be any one of the foreign rock asphalts or standard asphalt; the specifications are made to provide

for the use of either kind, and in every way permit a liberal and full competition.

The competition is now so close that the price of laying the pavements has been lessened very considerably and without detriment to the quality of the work. With granite pavements the competition has been even closer than with the asphalt, and has compelled quarry owners to introduce improved machinery and skill; by this means the cost of granite pavements has been reduced, notwithstanding that freights have been very high, and the prospect for the coming years is that paving blocks will be furnished at lower prices and the cost of the pavement lessened.

The following shows the comparison of the contract prices for granite and asphalt pavement on concrete foundations for 1888 and 1890 (asphalt for five years guarantee: Granite, 1888, $4 50; 1890, $3.65; asphalt, 1888, $3.75; 1890, $3.10.

These prices compare favorably with the cost of European pavements, without taking into consideration the increased cost of labor and materials in this city.

A great number of patent pavements and new combination of materials (asphalt) are offered for use and the city urged to make trials and experiments with them. Most of these have been tried elsewhere and proved of doubtful utility and were again offered under new names, and some were as yet untried, and your decision to allow none of them to be laid or tried at public expense must prove of great advantage in securing the pavements of known value.

The trial of a new pavement, to be of practical use, must be made on a large scale and on streets of heavy traffic; as such are in constant use, the laying down of a pavement for trial seriously interferes with private business, and if the patentee is required to remove it, misunderstandings have always followed and the city finally put to the expense of restoring the old pavement. Samples of compressed asphalt block pavement had been laid in this city at owners' expense, and had not proved in every way satisfactory.

It was decided not advisable to lay any of this pavement under the repavement laws, notwithstanding it has recently been laid in Washington and Baltimore in large quantities and given good satisfaction, and also the willingness of contractors to guarantee its maintenance or equal wearing with sheet asphalt pavements for five years.

The subways in London are in the center of the carriage way constructed of brick, twelve to fifteen feet wide and seven feet six inches high; through the subways is a foot-path; sometimes with rail tracks for hand cars, for the carrying of pipes and materials; brackets and other fixtures are placed to accommodate water and gas pipes, electric wires for light, telegraph, telephone and other conduits; beneath the subway is located the sewer and house drains extending to the houses. Access is had by manholes located at the side of the carriage way, some of which are sufficiently large for the taking in of pipes and other materials. The ventilation is had through these manholes.

The Paris subways are much larger and differ in having an uncovered channel for storm-water at the bottom; these sewers are not for use in carrying off sewage, but only storm-water and street-washings, and consequently are not foul. House drainage is still most generally into vaults and privies which are emptied by scavengers in the old-fashioned way.

The proposition to lay subway tunnels on both sides of the carriage way of Broadway would be both difficult and expensive, on account of the intricate net-work of pipes, conduits and vaults, that will be met with. The expense would be almost prohibitory, which the advantage would not warrant.

The use of wood in underground structures of street railroads, subways, manhole frames and stop-cocks of gas, water and steam, should be prohibited by law. The wood rapidly decays or is crushed and destroyed under the heavy-loaded vehicles, requiring frequent renewing, which necessitates the taking up of the pavements. In Fifth avenue the new pavement has been already taken up in several place for that purpose.

The wood stringers of the rail tracks in streets recently paved were found unfit for further use, being very much decayed and crushed; this was especially so in the older roads. The companies, in their own interest, renewed some of the worst, but retaining the greater portion, which will soon have to be renewed, which is sure to injure the pavements adjoining. The city has no authority over the companies in this matter.

Metal should be substituted for wood in all structures underlying pavements, which would be an economy to both city and company, and would insure good pavements.

The gas companies who have been required by you to replace all wooden stop-cock boxes with iron ones, and the few railroads who could be required to lay the metal stringer and improved rail, already appreciate the advantages of the change and will continue such improvements over all their works and tracks.

PAVING CONTRACTS IN ENGLAND.

MR. FRANK E. KIRBY, of Detroit, in a recent trip to England, was presented with a copy of a paving contract, which is given herewith, as it is full of pointers that may well be taken advantage of by boards of public work and city contractors. It is a tender for laying down and maintaining a wood pavement and foundations thereto in High Road from Hammersmith to Kew bridge, Parish of Chiswick:

The contractor is to take up the whole of the macadam and pitching of the present roadway, excavate the earth under the same to the required depth for the new foundation and pavement and immediately cart away surplus earth, material and refuse.

The roadways, when cleared of macadam and pitching, are to be excavated or filled in, as may be required, to the proper depths, and formed to such sections as the surveyor shall direct or approve, all low places being filled in, and all soft or otherwise unsound places being properly excavated or filled in solid with concrete, or otherwise, as shall be directed by the surveyor, without extra charge.

The new foundations are to be of concrete, six inches thick, at the least, in every part; but all excess of excavation, whether accidental or necessary, and all filling in, is to be made out or filled in with concrete, unless as to any soft or unsound or very low places the surveyor shall otherwise direct or allow.

The gullies are to be of earthenware, well burned, of a true shape and in a good condition, eighteen inches in diameter and four feet deep. The grates and frames to be of cast-iron, made of the very best gray metal, free from all defects.

The curb is to be of Norwegian granite, properly tooled, faced and squared on the exposed surfaces, twelve inches wide and nine inches deep, and no stone is to be less than three feet long.

The concrete for the new foundations and filling in is to be of Portland cement concrete, composed in the following manner: Six parts of the best Thames ballast and approved sifted granite to one part best quality Portland cement; the ballast to have such a proportion of small stones and clean, sharp Thames sand as that the whole mass shall form a concrete of the very best description. The concrete is to be finished and "floated" fair and true on the upper surface to the proper section for the new wood pavement to be laid upon it, the proportion of mixture to be one part of cement to five parts of ballast and sand; the finishing to be done at the same time as the filling in of the concrete, so that the whole may be entirely completed before any commencement to set has taken place. After the completion the new pavement is not to be laid upon it for six days, during which time the cement is to be kept damp and carefully protected from injury. Every proper care is also to be taken in the mixing and use of the cement. The Portland cement is to be of the best quality, and it shall be the duty of the contractor to obtain the best quality without any special instructions as to manufacturer or in other respects, weighing not less than one hundred and twelve pounds to the stacked bushel, and capable of maintaining a breaking weight of five hundred pounds seven days after having been made into blocks. The blocks must be immersed six of these days in water, and no cement must

be used until at least fourteen days after it has been received from the manufacturers; and in the event of the board or surveyor desiring to test the cement the contractor shall, without charge, afford every assistance and facility for such testing, except the supply of instruments or apparatus.

The new pavement is to be laid with the best Baltic yellow dent pickled blocks, or English beech, five inches deep, three inches wide and nine inches long, free from sapwood, large loose or dead knots or other defects, and to be cut die square, and laid with the grain vertical to the concrete surface in rows across the line of traffic, leaving a space between each row of blocks of one-fourth of an inch. These spans are to be filled with asphalt, then grouted with cement grout, composed of one part cement and three parts sharp river sand, and the whole to be covered with a top dressing of crushed Thames ballast one inch thick, to be worked into the joints by the traffic. At the street intersections the courses are to be laid diagonally so as to form a triangle with the apex towards the center of the road.

The contractor is at his own cost to provide all necessary labor and material for the completion of the work and proper maintenance of the same during the whole term of the contract.

The work is to be executed with the best of materials in the most workmanlike and substantial manner, under the direction and to the entire satisfaction of the surveyor, who shall have full power to reject any and all materials he may consider unfit to be used and any work he may consider improperly executed; and the contractor shall, immediately upon being required to do so by the surveyor, remove all rejected materials, and take up and re-execute to the surveyor's satisfaction all rejected work. The surveyor will also have power to require of the contractor the removal of any person whom he may deem incompetent or who are in any way objectionable to him.

The contractor is, at his own expense solely, to maintain in a state of perfect repair the whole of the new pavements and their foundations to the satisfaction of the surveyor, for the time of eight, fifteen or twenty years from the completion of the work.

The contractor shall also, if required by the board, maintain the pavements and foundations in good repair, at the board's expense, for a period of two years after the expiration of the eight, fifteen or twenty years, the surveyor, of course to have jurisdiction as before.

The new pavements and their foundations are to be absolutely the property of the board, and the latter is to be at full liberty to cleanse, water, sand or gravel the surfaces in such manner and at such time after their completion as it may see fit; and the board shall be entitled to exercise these and all other rights without incurring thereby any liability whatever to the contractor or in any way exonerating him from liability under his contract.

The contractor is to execute the work in such sections or subsections as the surveyor shall direct, so that the least possible inconvenience shall be occasioned either to the residents or the public. He is also to make arrangements for the attendance of police constables to regulate the traffic by night and day, and pay for the same. He is also to keep the work and adjacent foot-walks clear of all material, etc. At all times he is to carefully fence, light and watch the work during the progress and until completed.

The contractor during the whole term of his contract shall be held responsible for any defect which may take place by reason of the work in progress, or from want of repairs to the new pavements; provided always that he shall not be liable for accidents arising out of the opening of the ground at any time by the board or others, unless he shall have failed to properly repair the same after due notice.

The contractor is at all times during the continuance of the contract to repair within twenty four hours after notice all damage done the new pavements or foundations in consequence of the operations of the board, gas or water companies or other persons, and he is to do the work at the same price per superficial yard as in the original construction; and the contractor shall not commence, in any case, the work of repairs without the written consent of the surveyor.

Any damage done the curbstones, footway pavements, sewers, drains, gas or water mains and pipes, or to any other works by the workmen, or by reason of the works, shall be made good at the contractor's expense; all gas or water boxes, gully grates or other such appliances, must be raised or lowered as may be required to suit the new pavements, either by the contractor or the several gas or water companies, without expense to the board.

All works are to be executed and maintained under and during the continuance of the contract, under the direction and to the satisfaction of the surveyor, whose directions are to be followed and abided by in all respects, and his decisions on all questions connected with the contract shall be binding and final with all parties.

In case the contractor neglects or refuses to proceed with the works, or shall for forty-eight hours after receiving instructions from the surveyor, neglect or refuse to remove from the works any rejected materials, or re-execute poor work, or fail to properly maintain the new pavements or foundations, or become bankrupt or compound with his creditors, or shall attempt to assign or underlet or otherwise dispose of his contract, the board shall have full power to take possession of the works and all materials and plant in use or on the ground and employ other contractor or contractors, and the cost of such completion and maintenance shall be deducted from the amount due the original contractor.

The works are to be carried out in sections, as directed by the surveyor, and to be completed and ready for traffic within thirteen weeks from the day on which they were commenced; and the contractor shall forfeit $25 per day for any delay beyond the specified time; but if on account of bad weather or other unavoidable causes the contractor is unable to proceed with the works, the surveyor may grant such extension of time as he may consider reasonable.

The contractor will have to provide sureties satisfactory to the board in the sum of $10,000 for the proper fulfillment of the contract. The board does not bind itself to accept the lowest or any tender. The contractor is not allowed to underlet any part of the works, nor assign or otherwise dispose of his contract without the consent of the board.

It will be seen by the above that the surveyor is given the control of a dictator in the matter. It is very evident that he must be a thoroughly posted, practical man, and beyond the temptation of a bribe.

PUBLIC WORK IN OMAHA.

MR. GEORGE W. TILLSON, the city engineer of Omaha, in his annual report, just printed, says that Colorado sandstone has been substituted for all other stone in the curbing of that city. White Colorado is put in at a cost of seventy cents per foot, and the red at sixty-two cents. He says: "The quality of the Colorado stone is such that I consider that Omaha gets the best curbing of any city in the West. It is equal to any material that I have seen used for curb stones except granite. The total amount set during the season was 103,474.2 lineal feet (19.6 miles), at a cost of $70,399.49."

On the subject of paving Mr. Tillson says:

"The amount of pavement laid each year seems only to increase the desire for more. The council authorized the issue of $75,000 worth of intersection bonds, and contracts were immediately entered into for all the work that these funds would allow. Under our law the property owners in any paving district have the power of designating with what material such district shall be paved. Only three kinds of pavement were so designated in 1890, stone, asphalt and brick. The city is to be congratulated that the people have recovered from the wood craze that took possession of the public a few years ago. Wood never was, and never will be, a suitable material for paving in this climate. Cedar is bad enough, but cypress is worse. Twenty-ninth avenue from Leavenworth

to Hickory street was paved with that material in 1888. It must be completely repaved the coming season or the street practically abandoned for travel. Leavenworth street is in nearly as bad a condition. Other streets were paved with cypress the same year, but not having much travel, are not in as bad a condition at the present time. But it can be but a short time before all our wood pavements must be replaced.

"The paving problem is being discussed just as vigorously now as if it had recently been presented to the public. The proper material for a cheap and durable pavement is hard to find. Many experiments have been tried but with little success. The last material presented is vitrified brick. Reports from this vary greatly. In some places it has been a complete success; in others an utter failure. Omaha has a few miles of streets paved with brick. They came from Galesburg, Ill., Atchison, Kan., and Kansas City, Mo. I believe they are as good as the majority of bricks used thus far for pavement in this country. My own idea, based upon observation of these streets, is that brick is only suitable for pavement upon streets that have a small amount of traffic. Upon such streets where the pavement is wanted principally to make a clean and complete street, I believe they will give satisfaction if suitable brick are obtained and laid in a proper manner.

"After studying the subject carefully and hearing the experiences of other cities, as well as the opinions of many engineers, I am free to say that of all kinds of pavement in use at present, I believe stone and asphalt are the best and safest for any city to adopt. Stone is the cheapest, asphalt the most pleasant; stone for heavy business, asphalt for retail and residence streets. During the month of December I sent a circular letter to all the principal cities of this country, asking for information as to amounts and kinds of pavements in use. The following table has been compiled from the replies I have received. I have classified the different pavements as follows:

"Stone block and asphalt—first class.

"Cobble-stone and brick—second class.

"Macadam and wood—third class.

MILES OF PAVEMENTS PER 1000 INHABITANTS.

	Population.	1st Class.	2d Class.	3d Class.	Total.
Chicago	1,056,000	.03	.001	.55	.581
Philadelphia	1,050,000	.125	.496	.078	.699
Boston	447,000	.145	.02	.4	.565
Cincinnati	280,000	.125	.336	.45	.895
Cleveland	262,000	.197	.01	.05	.257
Buffalo	255,000	.87	.0	.004	.874
Detroit	207,000	.029	.032	.565	.626
Milwaukee	205,000	.031	.17	.147	.348
Toronto	200,000	.027	.0	.730	.757
Montreal	200,000	.036	.0	.65	.686
Washington	191,000	.594	.061	.042	.697
Newark	190,000	.065	.133	.016	.214
Minneapolis	165,000	.031	.0	.156	.187
Jersey City	163,000	.0	.316	.012	.328
Omaha	140,000	.237	.020	.177	.434
Kansas City	133,000	.053	.005	.466	.524
Denver	126,000	.002	.0	.0	.002
Providence	123,000	.081	.082	.0	.163
Indianapolis	108,000	.019	.285	.047	.351
Columbus	92,000	.202	.384	.0	.586
Worcester	85,000	.070	.176	.0	.246
Lowell	78,000	.138	.154	.0	.292
Memphis	65.000	.277	.161	.070	.508
Grand Rapids	64,000	.003	.018	.217	.238
Des Moines	51,000	.033	.066	.378	.479
Sioux City	38,000	.0	.0	.368	.368
London, Ont	35,000	.0	.0	.085	.085

"By reference to the above, it will be seen that Cincinnati has the most pavement per one thousand of population, but more than one-half is third-class, and only one-seventh first-class. Buffalo stands second with almost its entire amount first-class; Toronto is third, but ninety-seven per cent. is third-class; Omaha stands fourteenth, but over one-half is first-class. In the above classification I have considered that it is only a matter of time when all second and third-class pavements will be replaced or require a large annual expenditure for repairs. Taking then, first-class pavements only, we find that Omaha stands fourth in the list, headed only by Buffalo, Washington and Memphis. But coming to western cities of our own class, it is seen that in durable pavements, Omaha is far in the lead, as for some years it has been claimed for her.

"The actual amount of pavement in the tabulated cities is a follows:

Cobble stone	686.50 miles.
Rubble stone	117.60 "
Block stone	522.55 "
Wood	767.28 "
Asphalt	276.56 "
Macadam	773.40 "
Brick	47.29 "
All other	22.10 "

"Of the above amount of brick twenty-four miles is in Columbus, and very few cities of over 100,000 inhabitants report any.

"The amount and cost of the pavement laid in 1890, is as follows:

Material.	Miles.	Yards.	Cost.
Asphalt	4.70	106,317.6	$270,156 19
Sioux Falls (Stone)		7,418.2	16,758 44
Colorado (Stone)	1.76	42,531.1	108,738 75
Brick	2.35	52,335 2	100,453 55
Wood	0 40	8,702.2	11,965 52
Total	9.21	217,334.3	$508,072 45

An important change was made in the sewer specifications for 1890, requiring the use of Portland cement in all brick sewers. This, Mr. Tillson thinks, was of great benefit and apparently increased the cost of the work but a little. During the year there were constructed 64,015 lineal feet of sewers, at a total cost of $124,009.75. Deducting 1,624 feet for repairs and relaying, leaves 62,389 feet or 11.81 miles added to our system in 1890, making a total sewer mileage of 84.73.

The former street cleaning contract expired June 30, 1890. Prior to this, the mayor and council entered into a contract with C. E. Squires to sweep and clean all paved streets ordered by the board of public works, under new specifiications, for $15 per mile. Under this contract the principal business streets have been cleaned twice each week, others once each week, and the remainder once in two weeks. While it would be better to have all streets thoroughly cleaned at least once a week, fair results are obtainable under this rule. The total amount allowed for this work was $19,321.63.

THE GROWTH OF A YEAR.

WITH this number, PAVING AND MUNICIPAL ENGINEERING enters upon the second year of its existence. Although the success of the publication was, to the minds of the proprietors, well assured before the first number was issued, its growth in circulation, public favor and business patronage has been very gratifying. Its record has been quite remarkable, and, so far as we know, is without parallel in class journalism. It started under exceptionally auspicious circumstances, and it is a matter of pride as well as satisfaction that it has advanced in all respects even more rapidly than expected. The demand for the paper has been almost world-wide. Subscriptions are continually received from foreign countries, some even from points that by the quickest transportation are not reached in a month's time, the evidences of the far-reaching fame of the publication being often surprising to the publishers. We have strong assurances from those who have used the pages of the publication in the interest of their business that the results have been very satisfactory. Very good evidence of this is the growth of the advertising itself, all of which is of the most substantial character. Unlike many publications it has been the undeviating rule of the business management of PAVING AND MUNICIPAL ENGINEERING not to discriminate in its methods, in any respect, nor are assertions or promises made which can not be fulfilled to the letter, with something more for good measure. This is not referred to as something remarkable, but it is the exception rather than the rule. As a protection against irresponsible representation, we have refused to do business through any agencies. If business can not be done in our way we do not care to do it. We

have confidence, however, in our way. Some idea of the business progress of the journal may be obtained from the fact that in the first number there were advertisements by twenty-one different firms. In the last number, with which the year closed, there were seventy different advertisements. Several firms, after testing the advertising value of the paper, have increased their space. No one has given it a fair trial who has not continued. The prospects for the future are full of encouragement. With the beginning of the new volume we renew our assurance that we shall neglect no opportunity to promote the usefulness and value of the journal.

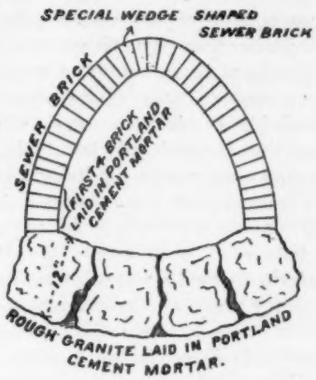
PUBLIC WORK IN DULUTH, MINN.

THE annual report of the Board of Public Works of Duluth, Minn., copies of which have just been received, gives the following interesting information regarding the public work done under the direction of City Engineer Fuller during the last year:

"There were 89,300 square yards of paving laid during the last year, as compared with 49,800 square yards the previous year, all of it being cedar block laid without tar. The experience of the year has gone to show that on grades between four and thirteen per cent. the best available pavement is cedar blocks, not exceeding six inches in diameter, laid in the usual manner, the interspaces being filled with a grout composed of Portland cement and sand. It is very important that the surface water be kept on top of the pavement on grades exceeding seven per cent., and on this account it is almost imperative that a concrete foundation be used. The damage occasioned by the slightest accumulation of water under a wood pavement on steep grades will cost more to repair than the interest would amount to on the capital required to be expended for the construction of concrete foundations.

"The use of tar composition on the surface of wood pavements was entirely dispensed with this year, it being found by experience that its use in this climate rather hastened than retarded decay, and that the extra cost of about seventeen cents per square yard was an unnecessary expenditure of money. On levels and slight grades the dust from the gravel strewed over the surface at the time of completion of the pavement soon works into the interspaces of the blocks, making an impervious roadway. On steep grades, Portland cement grout makes a more impervious filling between the blocks than tar. From the fact that the life of any pavement is largely dependent upon the life of its foundation, and as the subsoil of our streets is a clay which causes the customary three inches of sand to be an insufficient foundation, most of the pavement constructed this year has been built on a Telford foundation. This foundation consists essentially of two layers of stone; the first, six inches thick, composed of large stones thoroughly wedged together, all chinks being filled with smaller stones, the whole being covered with gravel and well wet and rolled with a twenty ton steam roller until compact and solid. The second, two inches thick, composed of a layer of stone crushed to a diameter of two inches or less, covered with gravel and wet and rolled as the first layer. On top of this foundation is sprinkled a thin layer of sand, on which is placed a layer of one-inch boards, the top of the boards affording a perfectly smooth and uniform surface on which to lay the blocks. A foundation as above described has the advantage over concrete, which has been used heretofore on our best business streets, of having every portion of the sub-grade thoroughly consolidated by the road-roller, as the rock of the foundation is sunken into all soft spots, which are often numerous. In preparing the sub-grade for concrete foundations, it was found that many spots must be left unrolled, being too soft for the roller to pass over. On the other hand, openings in Telford foundations for repairs to underground work can not be as completely restored to their original condition as can concrete foundations, it being impracticable to thoroughly consolidate Telford macadam without the use of a heavy roller.

"There have been 3.2 miles of sanitary sewers and 2.1 miles of storm-water sewers constructed during the past year, as against 3.7 miles and 2.9 miles respectively constructed the previous year, making a total of 19.1 miles of sanitary sewers, and 8.1 miles of storm sewers now in operation. The sanitary sewers have been constructed on the same lines as in previous years, but several new designs have been introduced into the storm sewers. The delta sewer as shown in the cut has been used frequently on steep grades in place of the vitrified pipe surrounded with concrete. Its advantage over the vitrified pipe is that the flat, rough granite surface reduces the velocity of the water, and at the same time presents a larger and tougher surface over which the debris which passes through the sewer can spread—both tending to reduce the scouring effect and to increase the life of the sewer. Where pipe laid in concrete has been used, all inlets have been provided with catch basins to keep the debris from the sewers."


SPECIAL WEDGE SHAPED SEWER BRICK
SEWER BRICK
FIRST BRICK LAID IN PORTLAND CEMENT MORTAR
ROUGH GRANITE LAID IN PORTLAND CEMENT MORTAR.

The report of Mr. Fuller, who has retired from office, is supplemented with valuable information by Mr. M. W. Lewis, the acting city engineer.

As to the sprinkling of streets by public contract, the report of Mr. George T. Hughes, the city clerk, gives the following information:

"About five and one-third miles of street were sprinkled by contract for six months, at a total cost of $3,994.97. The work was let in five contracts, the contractors furnishing everything requisite to the performance of the work.

"The cost per front foot under the different contracts was as follows:

Superior street, from Eighth ave. east to Eighth ave. west..	10.3 cents.
Superior street, from Thirteenth ave. west to Twenty-eighth ave. west...	5.9 "
First street, from Fourth ave. east to Eighth ave. west	9.12 "
Michigan street, from Thirteenth ave. west to Twenty-fourth ave. west..	6.72 "
Lake avenue, from Superior street to the ship canal	11.32 "

"The average cost per foot was 8.32 cents. The exhorbitant charges of the Duluth Gas and Water Company, for water, added greatly to the expense of this work. The contractor on West Superior and West Michigan streets procured water from adjacent streams, but the arrangement did not prove satisfactory, as the distance he was compelled to go for his supply interfered with the proper performance of the work. In St. Paul the cost of sprinkling seven months in the year varies from 6 to 7.5 cents per front foot for the season. In St. Louis the average price for eight and one-half months in 1890, was 3.534 cents per lineal foot of frontage."

BRICK PAVING IN DES MOINES, IOWA.

"YOU want to know what I know about brick paving, so far as it has been adopted in this city, do you?" said Mr. L. F. Andrews. "I believe you can not find a parallel in another city in the Union—for that matter I would include the whole system of paving. The first paving put down, you know, was on Walnut street, and it was a good job. The material was good and the work was well done. Subsequently the whole business of cedar block paving was manipulated in the interest of contractors, and between the unfitness of cedar blocks and craftiness of contractors cedar blocks became unpopular and were discarded. Then came the question of brick, the proper clay, and the process for making. Good paving brick requires a peculiar clay, and which must be

burned in a close oven or retort. You can not scrape up clay anywhere, run it through a feed mill, pile it up out doors like a cob house, and make paving brick. A brick may be hard and not worth a cent for paving. It requires a peculiar aluminum clay and expensive machinery and the expenditure of a large amount of money to furnish proper paving. To meet the probable demand all this has been furnished, and what do we see? The city council orders, say, Fourth street paved from Vine to Court avenue, and advertises for bids. Scores of samples, no two alike, and bids without samples are offered. The board of public works makes a selection and recommends its acceptance. The selection is properly made. The brick is the best presented. Bob Finkbine knows a good brick when he sees it. It is a good paving brick, but a member of the city council objects because the price, $1.70 per yard, is a few cents higher than was offered by somebody else who failed to put in a sample at all, and under a specious plea of economy he defeats the recommendation of the board of public works. The result will probably be that the street will be paved with brick like millions that have already been laid, totally unfit for paving, simply because they can be produced a little cheaper, and the contractor can make a little more money. A porous brick—one that will absorb moisture—is not fit for paving. It is expensive at any price, because it lacks durability. It will wear but a few years. A properly vitrified brick will wear under the heaviest traffic of this city thirty years, and is therefore cheaper at two dollars a yard than the other at one dollar. Why, Davenport and Rock Island are paying $1.74 for Galesburg brick, Omaha is paying $1.79 cash for Des Moines brick, which are fully equal to the Galesburg product; while in this city the contractor is obliged to take paving certificates which are worth only ninety-five cents on the dollar when put on the market. I have samples that you can not distinguish from the brick now going down in Columbus, Ohio, at $2.15 per yard, a contract of 175,000 square yards. The fact is that the whole system of paving here is wrong. There should be selected samples of acknowledged suitable, vitrified paving brick by the board of public works, and then bids be received for brick of like quality. Makers of paving brick would then be put in equal positions. They would each fix their price for the same article. The city should furnish the sample. The city would then get the lowest price for the best article instead of the highest price for the poorest."—*Des Moines, Ia., News.*

PERSONALS.

Mr. J. K. Wilkes has been elected city engineer of Danbury, Conn.

Mr. Winfield S. Gamble has been appointed city surveyor of Elgin, Ill.

Mr. L. J. H. Grossart has been elected city engineer of Allentown, Pa.

Mr. A. W. Smith has been re-elected city engineer, unanimously, of Kokomo, Ind.

Mr. C. G. Force has been appointed chief engineer of the Department of Public Works, Cleveland, Ohio.

Mr. W. T. McLean, of Sidney, Ohio, has been elected secretary of the Ohio State Board of Public Works.

Mr. E. H. Keating, city engineer and superintendent of waterworks, of Halifax, N. S., has been appointed city engineer of Duluth, Minn.

Mr. W. A. Eudaly, the inventor and builder of the well known Eudaly kiln, has recently sold, in Iowa, to three large plants, complete outfits of his kiln, for the burning of vitrified paving bricks.

Mr. Frank King, of Cincinnati, Ohio, has been appointed county engineer for Hamilton county, with office at Cincinnati, vice Mr. James Harper. Mr. King has been first assistant under Mr. Harper, for some years.

Mr. F. A. Dunham, of Plainfield, N. J., who has given special attention to street paving, has been appointed city engineer of Dunkirk, N. Y., where much brick paving is to be done. Mr. Dunham also has charge of paving in several other cities.

At the regular meeting of the Engineering Association of the South, in Nashville, Tenn., on Thursday, June 11, a paper on "Street and Highway Economics," by Mr. J. M. Heiskell, assistant engineer of the Memphis bridge, Memphis, Tenn., was read.

Mr. J. A. Stewart has been appointed chief engineer of street Passenger Railroad Route No. 23, in Cincinnati, and will soon begin the construction of it. It will be a belt road twelve miles long, with an incline plane 800 feet long leading to Fairview Heights in the western part of the city, and a tunnel 500 feet long through Eden Park in the eastern part of the city.

NEW PUBLICATIONS.

BRICK PAVEMENT. By C. P. Chase, City Civil Engineer, Clinton, Iowa. Price, $1.00. Publishers, PAVING AND MUNICIPAL ENGINEERING.

Mr. Chase's pamphlet gives concisely and comprehensively, the information most useful to people who desire a better knowledge of brick paving. He has made a thorough study of the subject, and has written some articles which have been published in PAVING AND MUNICIPAL ENGINEERING; others will continue to appear during the next several months. The pamphlet treats of the inauguration and execution of brick paving; the merits of paving brick and brick pavements, besides giving excellent and well considered specifications for the work in all its details. It is the best and most useful pamphlet on the subject that has been issued. Copies can be obtained from Mr. Chase, who is the city engineer of Clinton, Iowa, on the remittance of $1.

THE TECHNOGRAPH. By the Civil Engineers' Club and the Mechanical Engineers' Society of the University of Illinois.

No. 5, of the *Technograph* for 1890–91, just out, contains the papers of the Civil Engineers' Club and the Mechanical Society of the University of Illinois. The papers treat of subjects relating in nearly all branches of engineering and many of them are valuable. The contributors are, Selim H. Peabody, Oliver W. Cornet, F. W. Richart, Simeon C. Colton, I. O. Baker, F. R. Williamson, R. A. Mather, F. L. Bunton, B. A. Wait, J. H. Powell, A. E. Harvey, W. M. Hay, E. S Keene, S. D. Bawden, L. W. Peabody, W. A. Boyd, Arthur N. Talbot. Copies of the *Technograph* may be obtained by remitting to E. L. Scheidenhelm, business manager, Champaign, Ill., the sum of fifty cents.

INTERSTITIAL FILLING FOR BRICK PAVEMENTS.

THE May number of PAVING AND MUNICIPAL ENGINEERING contained an article on "Brick Paving in Memphis," in which Mr. Miles Merriwether, city engineer of Memphis, specified distilled coal tar pitch as a filler between the interstices of brick pavements. A letter from Mr. Merriwether states that the specifications were made before he had used any of the Gilsonite asphaltum, which he now considers superior to any coal tar pitch he ever saw.

TOLEDO'S PUBLIC IMPROVEMENTS.

THE annual report of Mr. Wickenden, city civil engineer of Toledo, Ohio, is out. It shows that during the last year there was 180,000 square yards of paving and macadamizing in Toledo, and 6,716 feet of eight-foot plank road put down. The total cost of these improvements was $489,813.17. The city now has 72 miles of improved streets, of which 14 miles are plank roads. All of this work has been done within five years. With the new system of sewers, ranging from one to six feet in diameter, the city also has over 68 miles of drainage, the construction of which cost $1,106,818.69. The cost of inspection of public work during the last year was $7,841. A steam road roller was operated during the year at an expense of $1,267.79, which was fully covered by the charges made for the use of it. The report contains much valuable statistical information.

Improvement and Contracting News.

PAVING.

Peoria, Ill., will pave with brick.

Terre Haute, Ind., favors brick paving.

Salem, Ore., will pave a number of streets.

Dubuque, Iowa, is talking granite paving.

Brick paving is all the go in Fort Smith, Ark.

Tipton, Ind., is paving her streets with brick.

Alton, Ill., favors brick for paving her streets.

Cardington, O., is going to pave her streets.

Barnsville, W. Va., wants to pave her streets.

Ottawa, Ill., intends to expend $24,000 on its streets.

Olympia, Wash., is agitating the question of paving.

Cedar Rapids, Ia., will pave twelve streets with brick.

Bushnell, Ill., wants to do some paving this season.

Cedar Rapids will pave the main streets in that city.

Grand Rapids, Mich., will do a lot of paving this year.

Elgin, Ill., will spend $45,000 for paving this summer.

Marion, Ala., is agitating the question of street paving.

Elgin, Ill., is agitating the question of street paving.

Muscatine, Ia., is still discussing the question of paving.

Oakland, Cal., will macadamize a number of her streets.

Boone, Ia., has voted to pave two of her streets with brick.

Ft. Wayne, Ind., will pave a number of streets with brick.

Memphis, Tenn., has eighty miles of streets to be paved.

Ironton, O., is paving a number of streets with vitrified brick.

Asheville, N. C., has appropriated $500,000 for street paving.

Superior, Wis., will pave a number of her streets this season.

Detroit, Mich., will pave a number of her streets with cedar blocks.

There will be a great deal of paving in Oshkosh, Wis., this season.

Barnesville, Ohio, has decided to pave Main street with fire-brick.

A big area of paving has been laid out for Portland, Me., this year.

Lexington, Ky., is agitating the question of vitrified brick pavements.

Virginia, Penn., has voted $420,000 for sewerage, paving and schools.

Sunnyside, Ore., will expend the sum of $20,000 on street improvements.

Three or four miles of sewerage and street pavement is the job that the city of Saginaw, Mich., will tackle this season.

Montello, Wis., people will put granite on the streets of that place.

Atlanta, Ga., is considering the question of paving with brick and asphalt.

Columbus, Ky., has appropriated $50,000 to the street and alley committee.

Quincy, Ill., will pave and re-pave a number of her streets this season.

Menominee, Mich., has voted $100,000 for street paving and sewer bonds.

Cedar Rapids, Ia., will put in thirty blocks of brick paving this summer.

Dubuque, Ia., will pave a mile or so of main street with Sioux Falls granite.

Fort Madison, Ia., has decided to pave several more of her streets with brick.

Leslie, Mich., has just put in a $500 stone crusher, and will macadamize her streets.

Wilmington, N. C., has voted $625,000 to pave her streets and increase her sewerage.

Williamsport, Pa., has several miles of paving to do this season and favors vitrified brick.

Ashland, Ill., is agitating the question of five miles of paving for the prominent streets.

Ogden, Utah, has decided to pave two and a half miles of her principal business streets.

Des Moines, Ia., will pave about six miles of her principal streets during the coming season.

Detroit, Mich., will pave about eight streets of that city with cedar blocks on concrete.

Evanston, Ill., talks of paving Ridge avenue through to its connection with Sheridan drive.

A petition is being circulated at Portland, Oregon, to have West Washington street paved.

Altoona, Ia., is thinking of investing some of the city's cash in a road scraper of some kind.

Columbiana, Ohio, citizens are hopeful of having Main street of that city paved with fire brick.

The city council of Boone, Iowa, has voted to pave the two principal streets with vitrified brick.

Appleton, Wis., has ordered $25,000 worth of paving on College avenue and Edwards street.

The Appleton, Iowa, council has ordered the laying of nearly a mile of block pavement this summer.

South Bend, Ore., will spend some $500,000 in street improvements, water-works and docks this season.

Williams & King, of Muskegon, will lay fifteen miles of cedar block pavement in Minneapolis for $150,000.

The Talbott Paving Company, Port Huron, Mich., will do $100,000 worth of paving in Chicago this summer.

The Pavers' Union, San Francisco, Cal., has passed a resolution tendering the board of supervisors a vote of thanks for passing the ordinance requiring stone blocks to be laid on a stone foundation of sand.

The Indianapolis Paving Company has been awarded contracts for $65,000 worth of brick paving in Danville, Ill.

Little Rock, Ark, is doing extensive street paving, and can justly boast of having the best streets in Arkansas.

Sealed bids will be received by the city auditor of the city of Clinton, Iowa, for an extensive amount of brick paving.

The Warren-Scharf Asphalt Company, of Cincinnati, are laying an asphalt pavement on Fourth street, Newport, Ky.

Mr. T. D. Kemp has been appointed engineer and superintendent of the Improved Wood Pavement Company at Mobile, Ala.

The paving problem at Salem, Ore., has been settled upon a pretty good foundation. Bids will be asked for different kinds of paving.

A special election will be held at Hackensack, N. J., to decide whether the town shall be bonded for $75,000 to macadamize its streets.

Sealed proposals will be received by the city clerk, Toledo, Ohio, until the 22d of June, for paving Bancroft street with Trinidad asphalt.

Keokuk, Iowa, has organized a paving brick company and is going into the business of making and laying a good article on her streets.

Boone, Ia., is very seriously discussing the question of paving, but how it will be done and what material used is still an open question.

Superintendent of Public Works Hudson, of Columbus, Ga., has commenced laying down stone crossings on Broad street and other business blocks.

Sealed proposals will be received by the board of public works for paving several streets in Cincinnati, O., with brick and constructing the necessary culverts.

The Warren-Scharf Asphalt Company has secured the contract for paving State street, Grand Rapids, Mich., with sheet asphalt. They will do the work for $23,573.

Proposals will be received by the city clerk, Toledo, O., until June 22, for improving Glenwood avenue by paving the central thirty feet thereof with Trinidad asphalt.

The council committee appointed by Elgin, Ill., to find out the cost of paving with cedar blocks, learned that it would, including curbing, etc., be from $1 to $1.25 per yard.

The election in Hackensack, N. J., to decide whether the town shall issue bonds to macadamize all the streets resulted in a victory for the progressive element; $25,000 will be expended.

Sealed proposals for asphalt pavements and foot-walks will be received at the War Department, Washington. D. C., until June 25, for constructing 2,300 square yards of asphalt pavement, 2,700 square yards, more or less, of asphalt walks, and for repairing 700 yards of asphalt walks in the public grounds.

The Southern Pavement Company, of Fort Payne, Ala., has been awarded the contract for paving with compressed asphalt blocks a portion of Lookout street, in Chattanooga, Tenn.

Fourth street, Market street and Chestnut street, in the block around the court house, St. Louis, Mo., will have the granite removed and cedar blocks put down, granite being objectionable on account of the noise.

SEWERS.

Charlottesville, Va., is agitating the sewer question.

West Duluth, Minn., wants a system of sewerage.

East Portland, Ore., wants a system of sewerage.

A number of sewers will be built at Bay City, Mich.

Boise City, Idaho, has voted $50,000 for a sewerage system.

Meridian, Miss., is agitating the question of a sewerage system.

Knoxville, Tenn., is still agitating the question of sewerage.

Asheville, N. C., has voted the sum of $100,000 for sewerage.

Plans are being laid for twenty miles of sewerage in Highlands, Col.

Red Wing, Minn., has decided to make a survey for a sewerage system.

Boise City, Idaho, has voted $100,000 in bonds to build a system of sewerage.

The question of sewerage is being strongly agitated by the citizens of Tampa, Fla.

Florence, Ala., is preparing to issue bonds to the amount of $40,000 for sewerage purposes.

Columbus, Neb., has raised the required capital, $3,000, and a system of sewerage will be put in.

Boise City, Wash., voted the other day to issue bonds in the sum of $90,000 for a system of sewerage.

Deadwood, Dak., is agitating the question of extending the sewerage system throughout the whole city.

Steps have been taken looking to the construction of a complete sewerage system for the entire city of Springfield, O.

The people of Fairhaven, Wash., have decided to bond the city for $250,000, the funds to be used in constructing a sewerage system.

Sealed proposals will be received until June 22, by Rogers' Park, Ill., for furnishing materials and labor for the construction of brick and pipe sewers.

G. A. Obendorfer, Chicago, Ill., has the contract for teaming for the sewer department for that city for the ensuing year. The contract amounts to about $25,000.

Correspondence is invited from an experienced sanitary engineer by the board of trustees of the town of Moscow, Idaho, for the purpose of obtaining a practical system of sewerage for said town. Address W. B. Kyle.

WATER-WORKS.

Elyria, O., will have water-works.

Peru, Ill., has voted $64,000 for water-works.

Zanesville, O., will be improved $40,000 worth.

Perry, Iowa, is advertising for bids for water works.

Cadillac, Mich., is negotiating for a water-works system.

Litchfield, Neb., proposes to have a water-works system.

North Baltimore, Ohio, will have a system of water-works.

Helena, Ark., has determined to build new water-works.

The water-works at Houston, Tex., have been condemned.

Sandwich, Mich., has decided to have a water-works system.

Three Oaks, Mich., will soon have a system of water-works.

Antonito, Colo., will expend about $28,000 on water-works.

Friend, Neb., will have a water-works system to cost $20,000.

West Union, Ia., will issue bonds for the erection of water-works.

Vermillion, S. D., will have a water-works system to cost $26,000.

Concord, N. H., has voted $200,000 for water-works improvements.

It is now certain that Baird, Tex., will have a system of water-works.

Luverne, Minn., has voted $30,000 in bonds for water-works system.

Lewis, Iowa, has voted a proposition to expend $3,000 for a water system.

Kenyon, Minn., has decided to put in a system of water works to cost $8,000.

Waitsburg, Wash., will have a system of water-works to cost not less than $29,000.

Luverne, Minn., will receive bids for the proposed water-works system at that place.

Milford, Mich., is now talking water-works, and will soon submit the matter to a vote.

Delphi, Ind., is to have water-works built on the same plan as the Huntington water-works.

Niles, O., has authorized the issuance of bonds in the sum of $50,000 for water-works.

Bridgeport, Ohio, has voted for the issuance of $25,000 worth of bonds for water-works.

Sheldon, Ia., is considering the question of contracting for a $20,000 water-works system.

The highest bid that Schuyler, Iowa, has yet on her $25,000 water-works bonds is $21,750.

Citizens of Russellville, Tex., will be called upon to vote on a $10,000 tax to build water-works.

Verndale, Minn., has authorized the issuing of bonds to the amount of $30,000 for water-works.

The mayor of Northfield, Minn., has been authorized to secure an estimate of the cost of water works.

Zimbrota, Minn., wants a fine iron bridge across Sand creek, between Jordan and the western addition of that city.

Russellville, Ky., will hold an election to vote on an appropriation of $12,000 for a water-works system.

Plymouth, Mich., will vote on the question of issuing of bonds to the amount of $20,000 for water-works.

Ft. Worth, Tex., is debating the investment of $500,000 in an extension and in improvements of its water-works.

Seattle, Wash., has authorized the board of public works to negotiate for the purchase of two 6,000,000 gallon pumps for the water-works.

The contract for a $50,000 system of water-works at Dawson., Ga., was awarded to the American Pipe Manufacturing Company, of Philadelphia.

BRIDGES.

Burlington, Ia., wants a new bridge.

The bridge question is being agitated at Munfordville, Ky.

A new iron bridge will be built at Knightstown, Ind.

Marshall, Ia., will build a bridge over the Kalamazoo river.

Youngstown, O., will build a $78,000 bridge over the Mahoning river.

It has been decided to build a fine bridge across Sand creek, at Jordan, Minn.

Duluth wants a wagon- and foot-bridge between that city and West Superior.

Marshall City, Mich., will build a bridge over the Kalamazoo river to cost $5,000.

Houghton county, Mich., will soon sell $15,000 worth of 5 per cent. bridge bonds.

The county commissioners at Julian, Neb., contemplate building a bridge near that place.

The bridge bond proposition has been carried by a large majority at South St. Paul, Minn.

O'Brien county, Iowa, will build iron bridges over the larger streams instead of wooden ones.

A company with $1,000,000 capital has been organized to build a third bridge at St. Louis, Mo.

Another company has been organized to build a bridge between Covington, Ky., and Cincinnati.

A new railroad bridge is talked of at Evansville, Ind., for the N. N. & M. V. railway company.

Sioux City, Iowa, will build a wagon and motor bridge across the river some time during the year.

Cache county, Utah, is considering the question of building a bridge over Bear river at Lewiston.

Steps are being taken to construct a bridge over the Cibolo, between Floresville, Texas, and Stockdale.

The county commissioners will build a one hundred foot bridge across Big Creek, south of Dupont, Ind.

Efforts are being made at Albion, Ill., to have an iron bridge built across the Wabash river at Beach Bluff.

Bids will soon be advertised for the construction of the bridge across the Mississippi river at Winona, Minn.

A steel bridge is to be built across the Willamette river at Albany, Ore., the estimated cost of which is $99,700.

Little Rock, Ark., is making efforts to build a bridge from West Third street extending over the railroad tracks to the hills.

The county clerk, Great Falls, Mont., has been instructed to advertise for bids for the construction of a bridge at Fifteenth street.

The Mt. Vernon Bridge Co., has received the contract for building the new High street bridge at Mt. Vernon, O, on a bid of $67,000.

W. A. Adams, of Des Moines, Iowa, has the contract for the Cascade bridge, at Great Falls, Mont. Work not to commence till July.

Ex-Territorial Auditor James A. Ward, of Pierre, is thinking of building a pontoon bridge across the Missouri river at Chamberlain, Iowa.

R. H. McLean, of Minneapolis, Minn., has secured the contract for building a magnificent new bridge across the Des Moines river at Des Moines, Ia.

In New York a project is on foot to connect the "L" roads of the metropolis and those of Brooklyn by two additional bridges over the East river at a cost of $24,000,000.

Plans for the bridge at Winona, Wis., have been approved by the government, and bids for the structure will be called for at once. The bridge is to cost about $80,000.

The necessary capital, $100,000,000, for the proposed New York and New Jersey bridge has been subscribed by a syndicate of capitalists, and the work will soon begin.

The proposed high bridge across the Mississippi, at Winona, Minn., has been definitely located at Johnson street, and the council will immediately advertise for bids.

Sealed bids will be received at Meda, Ore., for the building of a bridge across the Little Nestucka river near that place. Bids to be received until the first Wednesday in July.

The Ottawa, Kansas, county commissioners are talking of building a bridge across the Saline river, where it crosses the line between Lincoln and Ottawa townships.

County Commissioners, Mt. Vernon, O., have contracted with the Mt. Vernon Bridge Company, for a two hundred and ten foot bridge, single span, across the Kokosing river, for $6,700.

Bridge builders are invited to send bids for furnishing materials and the construction of an iron bridge across the Navasota river at Mickelboroughs Ferry, two and a half miles north of Navasota.

County commissioners, Boise City, Idaho, have agreed to meet on June 17th, for the purpose of advertising for bids for the construction of three bridges. One at Star, one at Falk's Store and another near the city.

The committee on the Channahon bridge, Joliet, Ill., have decided to reject all bids for the construction of same and advertise again, bids to be in three parts, one for stone and one for iron abutments, and one for the bridge entire.

SEALED PROPOSALS.

NOTICE TO CONTRACTORS.

OFFICE OF THE CITY CLERK,
Mansfield, O., May 20, 1891.

Sealed proposals will be received at this office until 12 o'clock noon, on Saturday, June 20, 1891, for the job of grading, paving sidewalks, curbing, and laying brick gutters and otherwise improving Lilly street from Orchard street on the south to Harker street on the north, in accordance with the plans and specifications for same now on file in this office.

Also at the same time and at this office sealed proposals will be received for the job of grading, setting curb-stone and paving roadway with brick and otherwise improving First street from Mulberry street west to Sturges avenue, in accordance with plans and specifications for same now on file in this office.

Also at the same time and at this office sealed proposals will be received for the job of grading, paving roadway with brick, curbing same and laying brick sidewalks and otherwise improving Willow street from Fourth street to Bloom street, in accordance with the plans and specifications for same now on file in this office.

Also at the same time and at this office sealed proposals will be received for the job of improving Fourth street by sewering same from Mulberry street on the east to the east line of lot No. 628, owned by Euretta Keffer, in accordance with the plans and specifications for same now on file in this office.

Each bid must contain the name of every person interested therein, and be accompanied with a sufficient guaranty of some disinterested person that if the bid is accepted a contract will be entered into and the performance of it properly secured.

All bids must be made upon blank forms, which can be had at this office.

Done by order of the city council, who reserve the right to reject any or all bids for said work.

Attest: JNO. Y. GLESSNER, City Clerk.

WATER-WORKS.

Notice to Contractors.

Sealed proposals will be received by the Village Council of Niles, Trumbull county, Ohio, until noon June 30, 1891, for furnishing material and constructing water-works for said village as follows:

One infiltration or supply basin, one building and one chimney, one storage reservoir, two pumping engines of 1,000,000 gallons each in 24 hours. Bids will be received for compound condensing and compound non-condensing machinery. Also two boilers for said works, including engine foundations, boiler setting, together with all pipes and fixtures complete.

Also the furnishing of 600 ft. of 14-in., 120 ft. of 12-in., 2,400 ft. of 10 in., 16,500 ft. of 8-in., 14,900 ft. of 6-in. and 12,750 ft. of 4 in. cast-iron coated water pipe, aggregating about 810 tons of 2,000 pounds. Also, about 22 tons of special castings; also, the laying of pipe and specials. Also, the furnishing of 80 fire hydrants, 56 stop valves and 56 valve boxes, and setting same.

Bids will be received for the Water-works System complete, or for any department of work, or material separately. The council reserves the right to reject any or all bids. Plans and detailed drawings can be seen at the office of the Village Council on and after June 10. Specifications furnished contractors by the consulting engineer or the village clerk. Proposals must be endorsed "Water-Works Proposal."

J. B. STRAWN, Consulting Engineer,
273 Lincoln Ave., Salem, Ohio.
M. J. FLAHERTY, Village Clerk, Niles, Ohio.

SEWERAGE SYSTEM.

Sealed proposals will be received at this office until July 6, 1891, at 12 M., for the building of a sewerage system for the city of Vicksburg, Miss., as per plans and specifications now on file in the office of the City Clerk. The Board of Mayor and Aldermen reserve the right to reject any and all bids.

R. V. BOOTH, Mayor.

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E. O. MCCORMICK, G. P. and T. A., Cincinnati, O.

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"DURABILITY OF BRICK PAVEMENTS," by Prof. Ira O. Baker. T. A. Randall & Co., Publishers, Indianapolis, Ind. Price 25 cents.

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The results, as shown in this little book, are suprisingly favorable to brick, and it will doubtless be accepted as a text-book by all interested in that line. The high standing and reputation of Prof. Baker, the author, as a civil engineer is ample evidence that the comparisons and statements are reliable and authentic.

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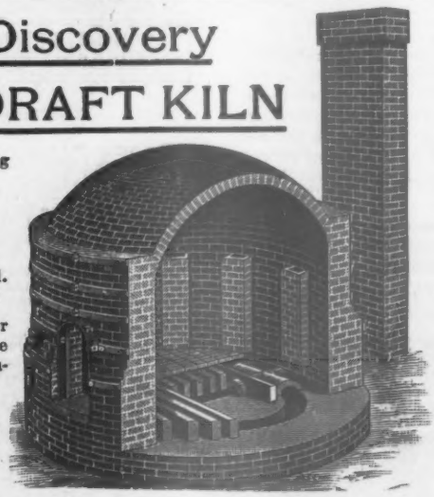

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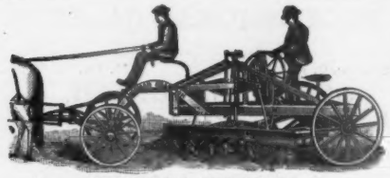

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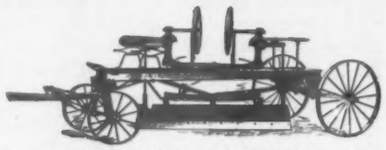

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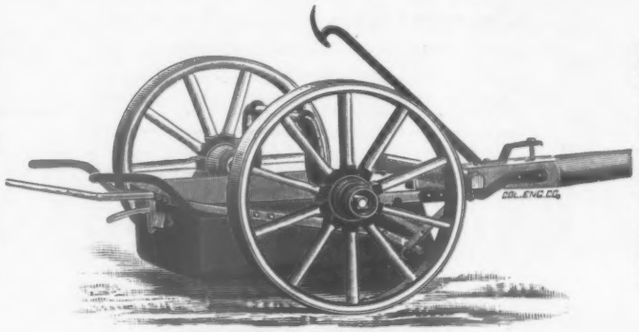

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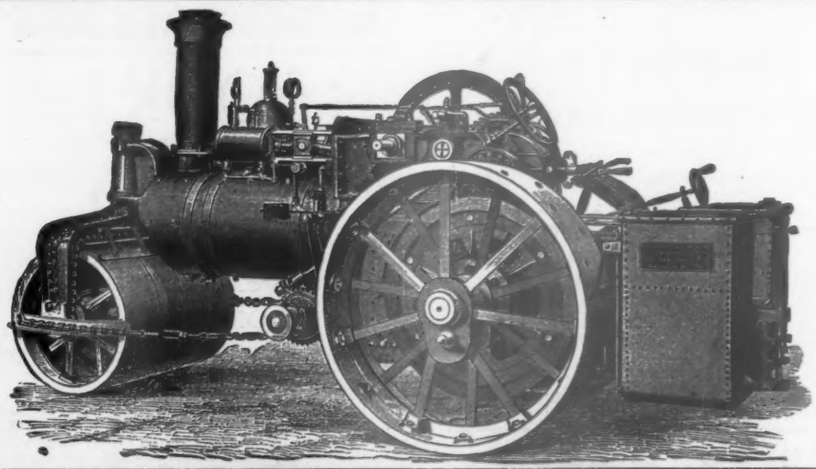

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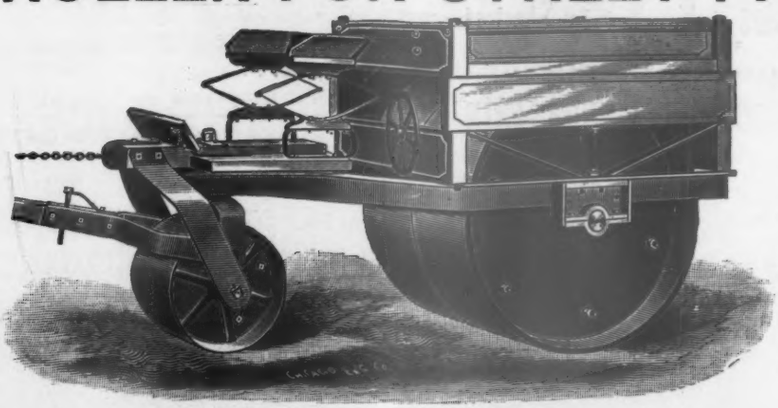

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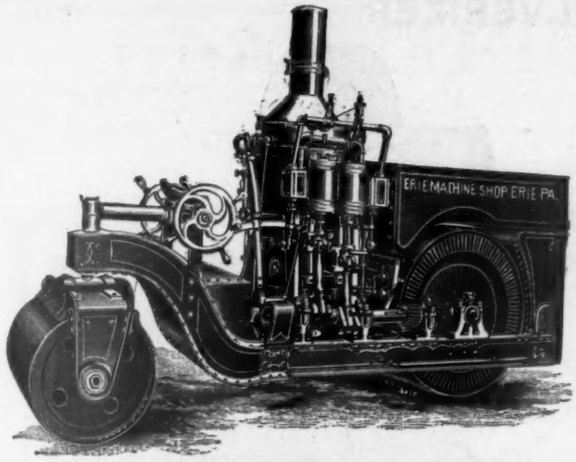

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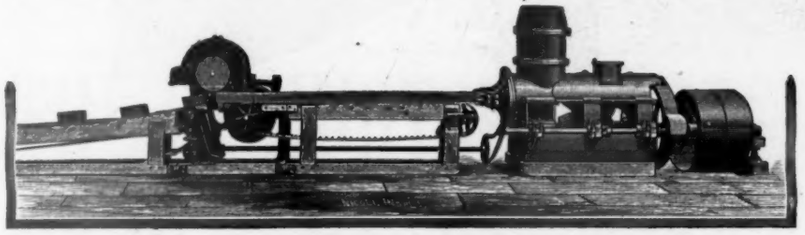

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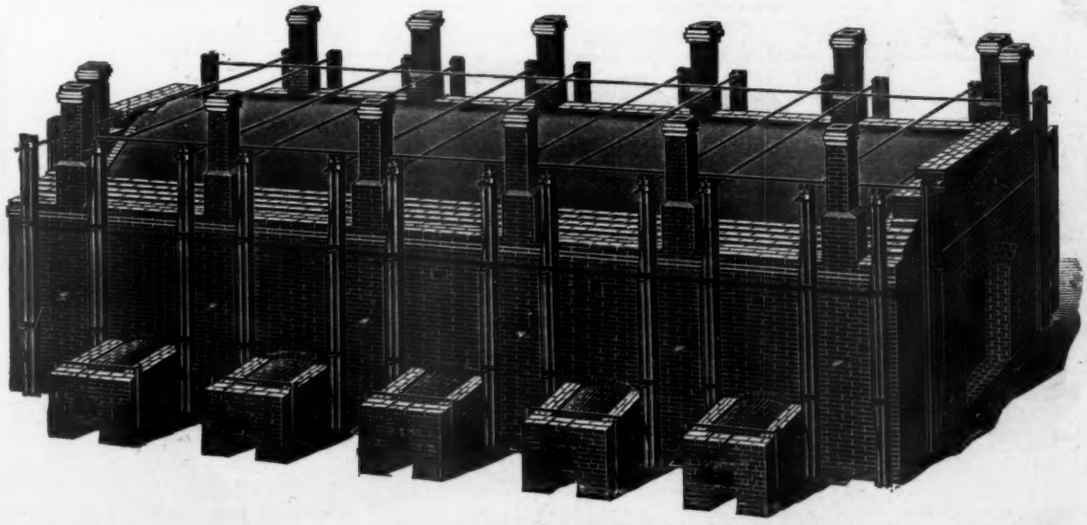

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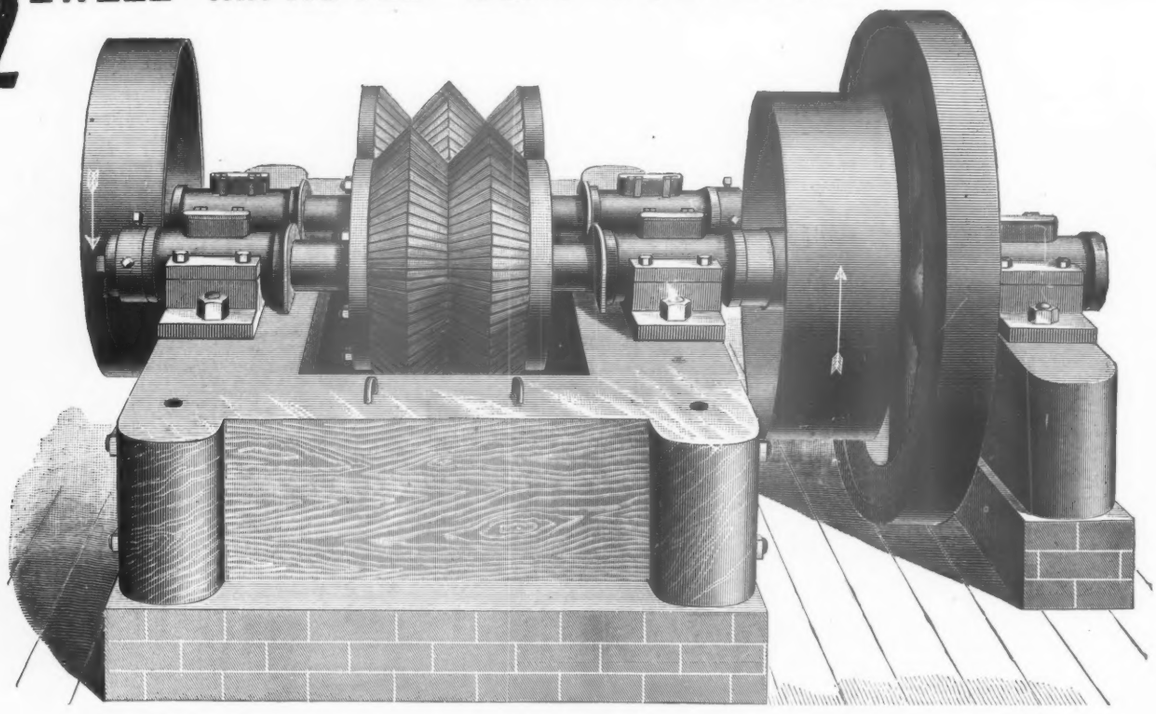

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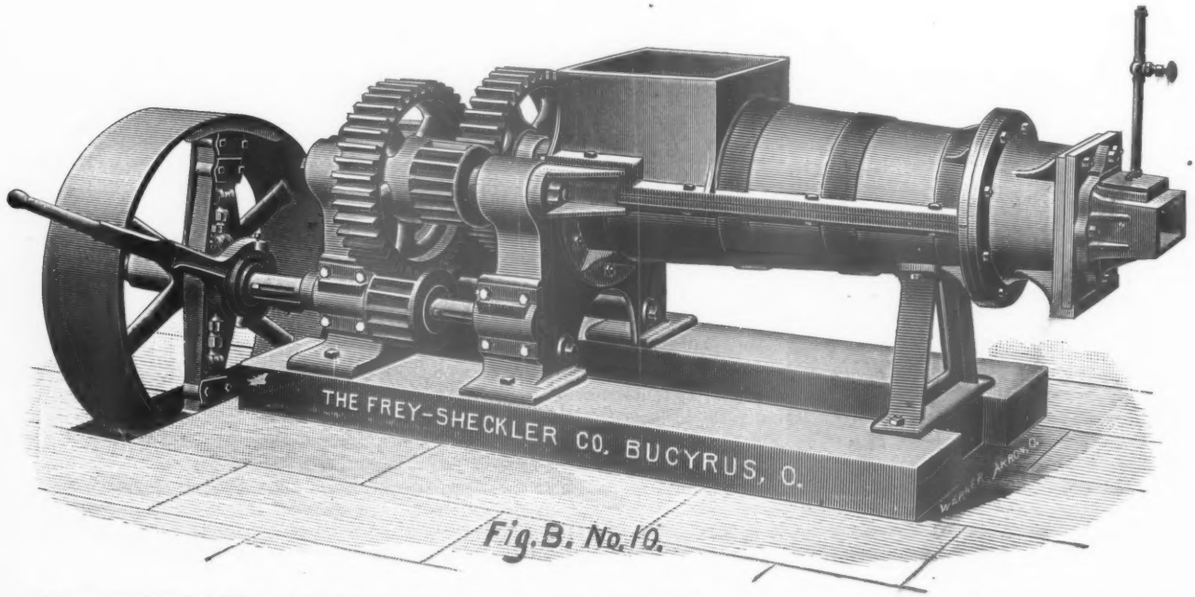

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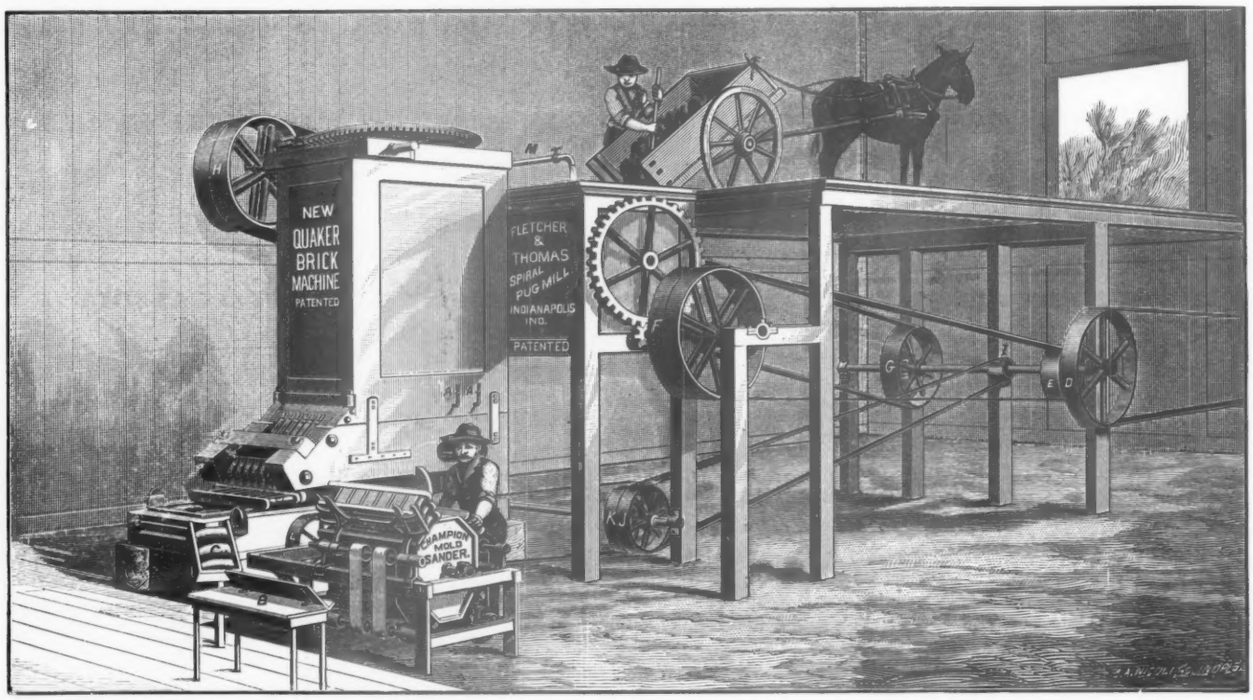

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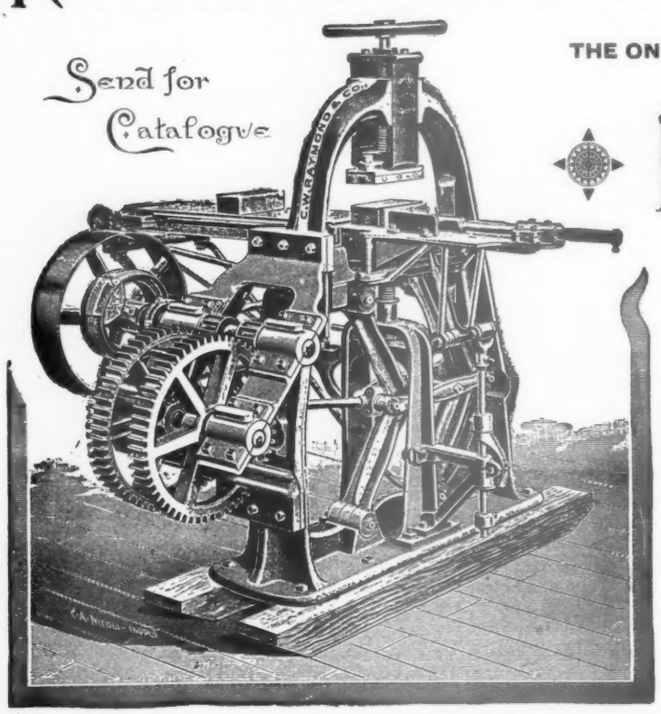

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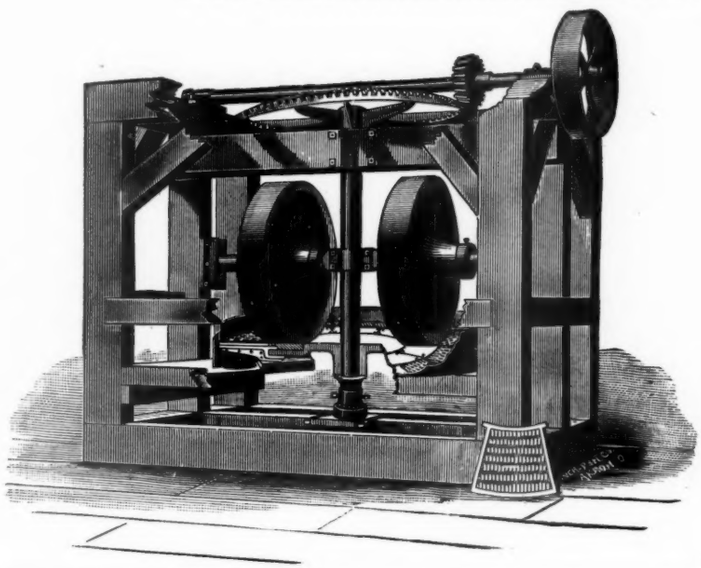

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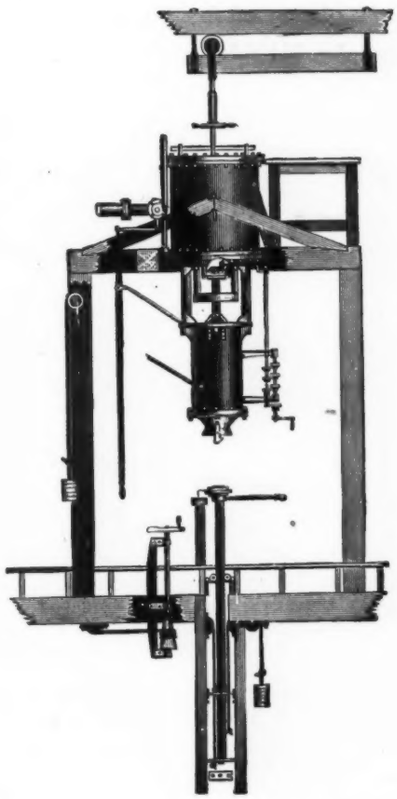

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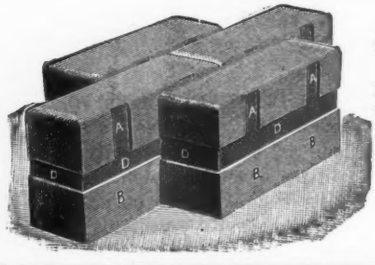

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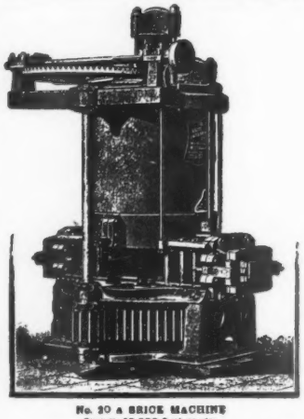
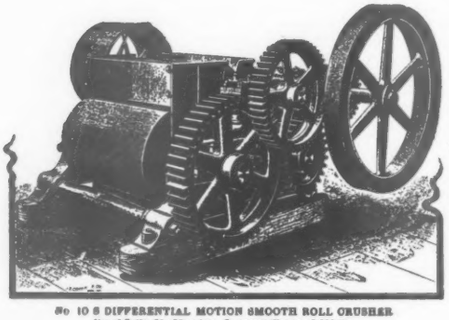
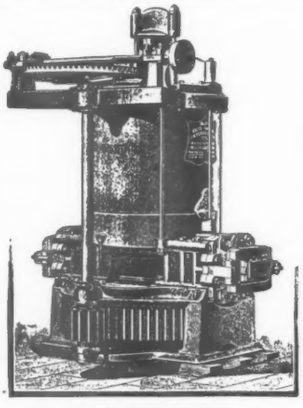


No. 20 A BRICK MACHINE
Capacity 60 000 Brick per day

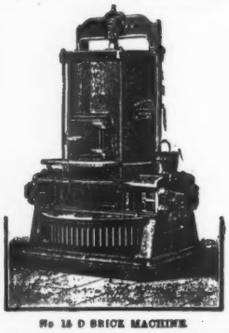


No 10 S DIFFERENTIAL MOTION SMOOTH ROLL CRUSHER
Size of Rolls, 24 x 30 inches Estimated Weight, 18,000 lbs.



No 20 B BRICK MACHINE

OUTFITS FOR MAKING PAVING BRICK, FIRE PROOFING AND TERRA COTTA LUMBER A SPECIALTY

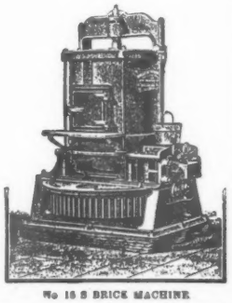


No 15 D BRICK MACHINE

No. 7 SPECIAL BRICK MACHINE

No 2 E HORSE-POWER BRICK MACHINE

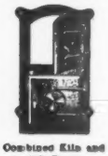
No. 6 SPECIAL TILE MACHINE



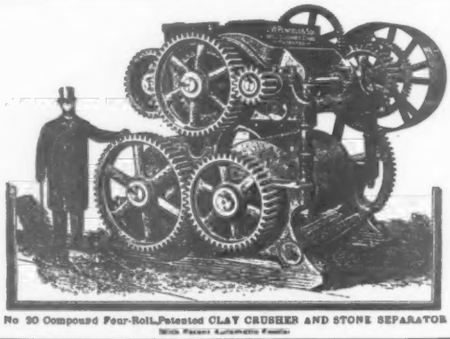
No 15 S BRICK MACHINE

THE LARGEST LINE OF CLAY CRUSHERS MANUFACTURED.

Cast Rings and Covers for Crowned Kilns



Combined Kiln and Ash Doors



No 20 Compound Four-Roll Patented CLAY CRUSHER AND STONE SEPARATOR

Line SHAFTING, Cast PULLEYS, Couplings, Hangers and KILN Castings.

FOR FULL PARTICULARS ADDRESS

J. W. PENFIELD & SON,

WILLOUGHBY, OHIO, U. S. A.